



Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

THE
ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW

VOLUME XV

April to September, 1898

NEW YORK

THE ENGINEERING MAGAZINE

1898

107107
71111



TA

1

F25

V.15

COPYRIGHT, 1898,
By JOHN R. DUNLAP.

INDEX TO VOLUME XV.

APRIL TO SEPTEMBER, 1898.

The titles first appearing under each classification-head are those of leading articles in the Magazine. The titles in smaller type, which follow, indicate articles from other journals which have been editorially noticed in the "Review of the Engineering Press."

ARCHITECTURE AND BUILDING.

	PAGE.
SYSTEMS AND APPARATUS FOR HEATING BUILDINGS	
BY STEAM. <i>J. J. Blackmore.</i>	28
With 12 Illustrations.	
AMERICAN AND ENGLISH PRACTICE IN ARCHITECTURAL	
STEEL CONSTRUCTION. <i>Charles V. Childs.</i>	233
With 3 Illustrations.	
HEATING BUILDINGS BY THE WARM-AIR SYSTEM. <i>J. J. Blackmore.</i>	430
With 8 Illustrations.	
ARCHITECTURAL WROUGHT-IRON ORNAMENT. <i>W. Martin Aiken.</i>	632
With 25 Illustrations.	
HEATING AND SANITATION OF PUBLIC INSTITUTIONS. <i>W. N. Twelvetrees.</i>	759
With 16 Illustrations.	
FIRE-RESISTING CONSTRUCTION—THE REGULATIONS	
IN FORCE IN LONDON. <i>G. A. T. Middleton.</i>	780

REVIEWS.

Beams, Efficiency of Built-up. 129	Engineer and Architect. 143
Building Stones. 305	Frame Work, Stability of. 323
Efficiency of Built-up Beams. 129	Hospitals, Sanitary Arrangement of. 132

INDEX to leading articles on Architecture in the Architectural and Engineering Press, including Construction and Design, Heating and Ventilation, Landscape Gardening, Plumbing and Gas-Fitting, and Miscellany. 155, 327, 501, 677, 849, 1043.

CIVIL ENGINEERING.

	PAGE.
EUROPEAN SEA-GOING DREDGES AND DEEP-WATER	
DREDGING. <i>E. L. Corthell.</i>	9
With 14 Illustrations.	
TANK IRRIGATION IN CENTRAL INDIA. <i>G. Palmer.</i>	59 & 289
With 9 Illustrations.	
THE INTERPRETATION OF SANITARY WATER ANALY-	
SIS. <i>Floyd Davis.</i>	68
II. Conditions Justifying Dredging, and the	
Resultant Benefits.	220
With 8 Illustrations.	
THE PURIFICATION OF RIVER-WATER-SUPPLIES. <i>Allen Hazen.</i>	249
With 8 Illustrations.	
UNPROFITABLE ENGINEERING PROJECTS IN WESTERN	
AMERICA. <i>A. G. Allan.</i>	440
With 13 Illustrations.	

THE IMPROVEMENT OF THE MISSISSIPPI RIVER BY DREDGING.	<i>H. St L. Coppée.</i>	458
With 9 Illustrations.		
NATIONAL INFLUENCE AND THE ISTHMIAN CANAL.	<i>Lewis M. Haupt.</i>	550
DILUTION PROCESS OF SEWAGE DISPOSAL.	<i>Rudolph Hering.</i>	575
THE NICARAGUA CANAL IN ITS COMMERCIAL AND MILITARY ASPECTS.	<i>Joseph Nimmo, Jr.</i>	720
AN EXAMPLE OF SUCCESSFUL JETTY CONSTRUCTION ON THE PACIFIC COAST.	<i>Gwynn A. Lyell.</i>	727
With 10 Illustrations.		
EUROPEAN AND AMERICAN BRIDGE CONSTRUCTION.	<i>Gustav Lindenthal.</i>	905
With 16 Illustrations.		
THE UNDERGROUND RAILWAYS OF LONDON.	<i>Frederick E. Cooper.</i>	928
With 17 Illustrations.		
BACTERIAL PROCESSES OF SEWAGE PURIFICATION.	<i>Rudolph Hering.</i>	960
With 7 Illustrations.		

REVIEWS.

Arch Bridge Over Ill (Austria), Construction	498	Movable Dams	130
Arch Construction, Modern.	498	Niagara Railway Arch.	475
Arches, Hinged Masonry.	825	Photo-Surveying.	310
Canal Lifts, Inclined Plane.	1033	Portland Cement.	1018
Canals for Large Traffic.	133	Purification of Drinking Water.	1030
Cement, Portland.	1018	Reservoirs, Compensating.	827
Cement, Silico-Portland.	152	Reservoirs, Loss of Water from.	830
Channels, Stability of.	144	Reservoirs Scheme, Staines.	665
Civil Engineers of France, Society of.	497	Retaining Walls, Theory of.	839
Cleveland Water Works.	657	Sanitation, Outcome of.	1031
Concrete Construction, Steel and.	307	Seine, Purification of the.	317
Croton Dam, New.	824	Sewer at Vienna, The New Collecting.	149
Dams, Movable.	130	Silico-Portland Cement.	152
Danube, Improvement of at Regensburg	673	Sliding Earth, Embankment in.	146
Drinking Water, Purification of.	1030	Staines Reservoirs Scheme.	665
Embankment Construction in Sliding Earth.	146	Steel and Concrete Construction.	307
Filtration Plant, A Large.	136	Stone Arch, History of the.	477
Flow of Water in Pipes.	651	Sweetwater Dam, The.	303
Frame-Work, Stability of.	323	Traffic, Canals for Large.	133
France, Society of Civil Engineers of.	497	Tunnel under the Strait of Gibraltar.	323
Gibraltar, Tunnel under the Strait of.	323	Underground Water-Supplies.	483
History of the Stone Arch.	477	Water, Measurement of Flowing.	319
Improvement of the Danube at Regensburg.	673	Water in Pipes, Flow of.	651
Masonry Arches, Hinged.	825	Water-Supplies, Underground.	483
Measurement of Flowing Water.	319	Water-Works, Cleveland.	657

INDEX to leading articles on Civil Engineering in the Engineering Press, including Bridges, Canals, Rivers and Harbors, Hydraulics, Irrigation and Miscellany 158, 330, 504, 679, 851, 1044.

ECONOMICS AND INDUSTRY.

	PAGE.
THE SHIFTING SITE OF NATIONAL INDUSTRIAL SUPRE- MACY.	<i>J. Stephen Jeans.</i> 1
FUTURE INDUSTRIAL OPPORTUNITIES OF CUBA.	<i>Wilfried Skaiße.</i> 363
THE DEVELOPMENT OF THE RAILWAYS OF CANADA.	<i>Walter E. Weyl.</i> 387
SEA POWER AT THE END OF THE NINETEENTH CEN- TURY.	<i>W. Laird Clowes.</i> 539
NATIONAL INFLUENCE AND THE ISTHMIAN CANAL.	<i>Lewis M. Haupt.</i> 550
THE NICARAGUA CANAL IN ITS COMMERCIAL AND MILITARY ASPECTS.	<i>Joseph Nimmo, Jr.</i> 720
COMPARATIVE POINTS OF INTERNATIONAL PATENT LAW.	<i>J. Sinclair Fairfax.</i> 952

REVIEWS.

Education of Miners.....	313	Liquefied Air.....	481
Education, Technical.....	309	Paris International Exhibition.....	838
French Academy, Prizes of the.....	145	Prizes of the French Academy.....	145
Glacier Ice, Utilisation of.....	494	Progress in Engineering, A Year's.....	1017
Grain Imports, Water Transport and.....	670	Technical Education.....	309
India, Iron Resources of.....	663	Timber Physics, Progress in.....	823
International Exhibition, Paris.....	838	Utilisation of Glacier Ice.....	494
Japan, Railway Business in.....	316	Water Transport and Grain Imports.....	670

INDEX to leading articles on Economics and Industry and Industrial Sociology in the Engineering Press, and Current Reviews, including Commerce and Trade, Currency and Finance, Governmental Control, Labor and Miscellany.....160, 333, 507, 682, 854, 1047.

ELECTRICAL ENGINEERING.

PAGE.

THE STEAM ENGINE AND THE DYNAMO—A CHAPTER

IN EVOLUTION.	<i>Charles T. Child.</i>	105
-----------------------	--------------------------	-----

APPLICATIONS OF ELECTRICITY ON A MODERN WAR-SHIP.

<i>George H. Shepard.</i>	280
---------------------------	-----

RECENT APPLICATIONS OF ELECTRO-CHEMISTRY TO THE METAL INDUSTRIES.

<i>Sherard Cowper-Coles.</i>	594
------------------------------	-----

THE APPLICATION OF ALTERNATING CURRENTS TO ELECTRIC TRACTION.

<i>Charles Henry Davis.</i>	811
-----------------------------	-----

<i>Howard C. Forbes.</i>	972
--------------------------	-----

With 10 illustrations.

REVIEWS.

Aluminum for Electrical Conductors.....	131	Mountain Roads, Electric.....	151
Conductors, Aluminum for Electrical.....	131	Niagara Hydraulic Power Plant.....	1023
Cost of Electrical Energy.....	659	Overhead Trolley, Sliding.....	324
Efficiency, Incandescent Lamp.....	652	Parabolic Reflectors.....	311
Electrical Buoy, Wave Power.....	143	Plows, Electric Motor.....	839
Electric Driving of Machine Tools.....	662	Power Plant of Quai de Jenappes.....	147
Electric Motor Plows.....	839	Reflectors, Parabolic.....	311
Electric Traction, Progress of.....	481	Sliding Overhead Trolley.....	324
Electrical Vision.....	1019	Telegraphy Across Space.....	487
Energy, Cost of Electrical.....	659	Tempered Steel, Magnetic properties of.....	148
Engines for Electric Traction.....	137	Traction, Engines for Electric.....	137
Incandescent Lamp Efficiency.....	652	Transmission of Energy, Electrical.....	1035
Incandescent Lamps.....	322	Transport Facilities, Improvement in.....	138
Machine Tools, Electric Driving of.....	662	Wireless Telegraphy.....	487

INDEX to leading articles on Electrical Engineering in the Engineering Press, including Electro-Chemistry and Metallurgy, Lighting, Power, Telegraphy and Telephony, and Miscellany...163, 336, 509, 684, 856, 1048.

MARINE ENGINEERING.

PAGE.

THE DEVELOPMENT OF THE TORPEDO-BOAT DESTROYER.

<i>John Platt.</i>	189
--------------------	-----

With 22 Illustrations

APPLICATIONS OF ELECTRICITY ON A MODERN WAR-SHIP.

<i>George H. Shepard.</i>	280
---------------------------	-----

MECHANICAL OPERATIONS IN THE MANUFACTURE OF A GREAT NAVAL GUN.

<i>Edwin J. Prindle.</i>	371
--------------------------	-----

With 14 Illustrations.

SEA-POWER AT THE END OF THE NINETEENTH CENTURY.

<i>W. Laird Clowes.</i>	539
-------------------------	-----

THE HIGH-SPEED STEAM YACHT AS A FACTOR IN TORPEDO-BOAT DESIGN.

<i>W. P. Stephens.</i>	
------------------------	--

I. The Historical Development in England and America.

621

With 5 Illustrations.

II. The Successful Solution of the Problem of High-Speed. 786

With 11 Illustrations.

THE NAVIES AND NAVAL CONSTRUCTION PROGRAMME
OF 1898. *H. W. Wilson.* 711

THE ESSENTIAL ELEMENTS OF MODERN SEA POWER. *P. H. Colomb.* 889

REVIEWS.

American Battleships, The New	826	Launch of the Amphitrite	1025
Auxiliary Machinery, Wastefulness of.	301	Pipes, Bursting of Copper	316
Battleships, The New American.	825	Safety at Sea.	1025
British Navy, Water-Tube Boilers in.	489	Ship Models and Experimental Tanks.	840
Copper Pipes, Bursting of	316	Steam Auxiliaries, Possible Economies in.	484
Economies in Steam Auxiliaries, Possible.	484	Thermopile as a Fog Signal.	1020
Engine Shafts, Marine.	673	Water-Tube Boilers, Evaporation in.	486
Evaporation in Water Tube Boilers.	486	Water-Tube Boilers in British Navy.	489
Experimental Tanks, Ship Models and.	840		

INDEX to leading articles on Marine Engineering in the Engineering Press and Current Reviews, including Boilers and Engines. Naval Affairs, and Miscellany. 168, 340, 513, 688, 861, 1054.

MECHANICAL ENGINEERING.

AN EFFECTIVE SYSTEM OF FINDING AND KEEPING
SHOP COSTS. *Henry Roland.*

I. Simplicity and Sufficiency of the Job-
Ticket Method. 77

II. The Collective Job-Ticket Adapted to
Drop-Forging Works. 241

III. The Methods of a Successful Machine-
Tool Works. 395

IV. Ingenious Methods of a Modern Mach-
ine-Tool Works. 610

With 1 Illustration.

V. The Hyatt Roller Bearing Company's
Practice. 749

With 4 Illustrations.

VI. The Sprague Electric Company's Sys-
tem. 1000

THE STEAM ENGINE AND THE DYNAMO—A CHAPTER
IN EVOLUTION. *Charles T. Child.* 105

THE GAS ENGINE IN AMERICAN PRACTICE. *George Richmond.* 113

With 14 Illustrations.

ECONOMICAL USE OF STEAM IN NON-CONDENSING
ENGINES. *James B. Stanwood.* 213

MECHANICAL OPERATIONS IN THE MANUFACTURE OF
A GREAT NAVAL GUN. *Edwin J. Prindle.* 371

With 14 Illustrations.

THE UTILISATION OF BLAST-FURNACE GAS FOR THE
PRODUCTION OF POWER. *W. H. Booth.* 420

With 1 Illustration.

RECENT APPLICATIONS OF ELECTRO-CHEMISTRY TO
THE METAL INDUSTRIES. *Sherard Cowper-Coles.* 594

With 5 Illustrations.

THE ECONOMICAL USE OF STEAM IN NON-CONDENSING

ENGINES. *James B. Stanwood.* 603

With 3 Illustrations.

NEGLECTED CONSIDERATIONS IN THE ARRANGEMENT

OF STEAM PIPING. *W. Cooper.* 740

ENGINEERING LESSONS FROM THE HISPANO-AMERICAN

WAR. *Hiram S. Maxim.* 898

THE COMPARATIVE COST OF STEAM AND WATER

POWER. *William O. Webber.* 922

REVIEWS.

Acetylene, Present Status of.....	1029	Governors, Water Wheel.....	304
Air Compressors at High Altitudes	656	Hydraulic Jointing.....	139
Automobile Cabs.....	1037	Hydraulic Rams.....	134
Automobile Vehicles	668	Jointing, Hydraulic	139
Automobile Vehicles, Heavy.....	845	Laundry Machinery, Steam.....	836
Automotor Trials, The Liverpool.....	832	Live Steam, Feed-Water Heating with	485
Auxiliary Machinery, Wastefulness of	301	Lubricating Oils, Testing of.....	841
Balancing Steam Engines	661	Machine Shops, Remodelling	302
Bicycles, Testing	828	Machine Tools, Electric Driving of	662
Blast-Furnace Power Gas	667	Machinery, Gas-Works	834
Blast-Furnace Gases, Power from	480	Marine Engine Shafts	673
Boiler Furnaces, Gauging	315	Moisture in Steam, Determination of.....	842
Cable, Test of a Heavy	844	Nozzles, Experiments with Diverging	496
Chains, The Wear of.....	1032	Pipes, Bursting of Copper	316
Compression Tests, Wrought Iron	652	Pneumatic Despatch Tubes.....	1022
Consulting Engineer, Duty of.....	837	Power from Blast Furnace Gases	480
Copper Pipes, Bursting of	316	Power from Furnace Gases ..	139
Crane, A Powerful	671	Producer Gas, Power from... ..	1023
Crank Arrangement in Quadruple Engines ..	660	Quadruple Engines, Crank Arrangement in..	660
Depreciation of Machinery.....	1026	Radial Valve Gears ..	493
Diesel Motor in America	135	Rams, Hydraulic	134
Diverging Nozzles, Experiments with.....	496	Refractory Surfaces in Furnaces.....	481
Duty of the Consulting Engineer	837	Ship Models and Experimental Tanks.....	840
Economies in Steam Auxiliaries, Possible... ..	484	Steam Auxiliaries, Possible Economies in ..	484
Efficiency of Steam Jackets.....	479	Steam Boilers, Care of.....	140
Electric Driving of Machine Tools.....	662	Steam Cylinders, Compression in	1034
Electric Traction, Engines for	137	Steam, Determination of Moisture in	842
Engineer and Architect	143	Steam Engine Trials	653
Engine Shafts, Marine.....	673	Steam Engines, Balancing.....	661
Engines for Electric Traction	137	Steam Jackets, Efficiency of	479
Evaporation in Water-Tube Boilers	486	Steam Laundry Machinery	836
Experimental Tanks, Ship Models and.....	840	Steam Pumps, Wasteful.....	831
Explosions, Fly-Wheel	493	Tempered Steel, Magnetic Properties of ...	148
Feed-Water.....	662	Testing Bicycles	829
Feed-Water Heating with Live Steam	485	Testing Material, Notes on... ..	318
Fly-Wheel Explosions.....	493	Traction, Engines for Electric	137
Friction, Internal	321	Transmission of Power.....	1020
Furnace Gases, Analyses of.....	308	Valve Gears, Radial.....	493
Furnace Gases, Power from	139	Vehicles, Automobile.....	668
Furnaces, Refractory Surfaces in	481	Vehicles, Heavy Automobile	845
Gas Engine Research....	312	Water-Tube Boilers, Evaporation in	486
Gas-Works Machinery..	334	Water-Wheel Governors	304
Gauging Boiler Furnaces.....	315	Wrought Iron Compression Tests.....	652

INDEX to leading articles on Mechanical Engineering in the Engineering Press, including Boilers, Furnaces and Firing, Compressed Air, Engines and Motors, Power and Transmission, Shop and Foundry, and Miscellany..... 169, 342, 514, 689, 862, 1055.

MILITARY ENGINEERING.

PAGE.

THE DEVELOPMENT OF THE TORPEDO-BOAT DE-

STROYER. *John Platt.* 189

With 22 Illustrations.

APPLICATIONS OF ELECTRICITY ON A MODERN WAR-SHIP.	<i>George H. Shepard</i>	280
MECHANICAL OPERATIONS IN THE MANUFACTURE OF A GREAT NAVAL GUN.	<i>Edwin J. Prindle.</i>	371
With 14 Illustrations.		
SEA POWER AT THE END OF THE NINETEENTH CENTURY.	<i>W. Laird Clowes.</i>	539
NATIONAL INFLUENCE AND THE ISTHMIAN CANAL.	<i>Lewis M. Haupt.</i>	550
THE HIGH-SPEED STEAM YACHT AS A FACTOR IN TORPEDO-BOAT DESIGN	<i>W. P. Stephens.</i>	
I. The Historical Development in England and America.		621
With 5 Illustrations.		
II. The Successful Solution of the Problem of High Speed.		786
With 11 Illustrations.		
THE NAVIES AND NAVAL CONSTRUCTION PROGRAMME OF 1898.	<i>H. W. Wilson.</i>	711
THE NICARAGUA CANAL IN ITS COMMERCIAL AND MILITARY ASPECTS.	<i>Joseph Nimmo, Jr.</i>	720
THE ESSENTIAL ELEMENTS OF MODERN SEA POWER.	<i>P. H. Colomb.</i>	889
ENGINEERING LESSONS FROM THE HISPANO-AMERICAN WAR.	<i>Hiram S. Maxim.</i>	898
REVIEWS.		
American Battleships, The New.	826	Experimental Tanks, Ship Models and. 840
British Navy, Water-Tube Boilers in.	489	Launch of the Amphitrite 1025
INDEX to leading articles on Military Engineering in the Engineering Press, including Ordnance, Armour, Ammunition, and Miscellany. 519, 694, 868, 1059.		

MINING AND METALLURGY.

	PAGE.
MINING THE GOLD ORES OF THE WITWATERSRAND.	
<i>H. H. Webb and Pope Yeatman.</i>	
I. Practice in Dealing with General Mining Problems.	39
With 11 Illustrations.	
II. Special Conditions of Labor, Supplies, and Environment	261
With 17 Illustrations.	
III. Mechanical Equipment and Operative Details.	401
With 17 Illustrations.	
UTILISATION OF BLAST FURNACE GAS FOR THE PRODUCTION OF POWER.	<i>W. H. Booth.</i> 420
With 1 Illustration	
CYANIDE PROCESS AS APPLIED ON THE RAND.	<i>W. Leonard Holmes.</i> 584
With 5 Illustrations	
THE GOLD RESOURCES OF INDIA.	<i>Wm. King.</i>
	<i>Theo. W. Hughes Hughes.</i> 797
THE BAKU PETROLEUM DISTRICT OF RUSSIA.	<i>David A. Louis.</i> 986
With 8 Illustrations.	

REVIEWS.

Analyses, Pig-Iron.....	476	Iron and Steel, Testing.....	656
Anti-Friction Alloys.....	1038	Metallography, Progress of.....	478
Blast-Furnace, Heat Balance of the.....	846	Mining Claims in River Beds.....	306
Blast-Furnace Gases, Motors for.....	1036	Mining Progress, Twenty Years'.....	831
Blast-Furnace Gases, Power from.....	480	Nickel-Steel, Properties of.....	491
Cast-Iron, Testing.....	826	Pig-Iron Analyses.....	476
Coke Oven, Simon-Carves.....	488	Pig-Iron, Sampling for Analysis.....	654
Collieries, High Pressure Steam at.....	1027	Power from Blast-Furnace Gases.....	480
Education of Miners.....	313	River Beds, Mining Claims in.....	306
Engineering Appliances in Mining.....	141	Safety Mining Lamps.....	833
Fire-Damp, Electrical Ignition of.....	150	Sampling Pig-Iron for Analysis.....	654
Grisometer.....	672	Simon-Carves Coke Oven.....	488
Heat Balance of the Blast-Furnace.....	846	Steel, Progress in the Study of.....	843
High Pressure Steam at Collieries.....	1027	Steel, Testing Iron and.....	656
Iron Resources of India.....	663	Testing Cast Iron.....	826

INDEX to leading articles on Mining and Metallurgy in the Engineering Press, including Coal and Coke, Copper, Gold and Silver, Iron and Steel, Mining, and Miscellany.... 174, 347, 520, 695, 869, 1060.

MUNICIPAL ENGINEERING.

	PAGE.
THE INTERPRETATION OF SANITARY WATER ANALYSIS.	<i>Floyd Davis.</i> 68
THE PURIFICATION OF RIVER WATER-SUPPLIES.	<i>Allen Hazen.</i> 249
With 8 Illustrations.	
DILUTION PROCESS OF SEWAGE DISPOSAL.	<i>Rudolph Hering.</i> 575
THE UNDERGROUND RAILWAYS OF LONDON.	<i>Frederick E. Cooper.</i> 928
With 17 Illustrations.	
BACTERIAL PROCESSES OF SEWAGE PURIFICATION.	<i>Rudolph Hering.</i> 960
With 7 Illustrations.	

REVIEWS.

Cleveland Water Works.....	657	Reservoirs Scheme, Staines.....	665
Croton Dam, New.....	824	Sanitation, Outcome of.....	1031
Drinking Water, Purification of.....	1030	Sewer at Vienna, The New Collecting.....	149
Filtration Plant, A Large.....	136	Staines Reservoirs Scheme.....	665
Reservoirs, Compensating.....	827	Water-Supplies, Underground.....	483
Reservoirs, Loss of Water from.....	830	Water-Works, Cleveland.....	657

INDEX to leading articles on Municipal Engineering in the Engineering Press, including Gas Supply, Sewerage, Streets and Pavements, Water-Supply, and Miscellany 180, 351, 526, 699, 875, 1064.

RAILWAY AFFAIRS.

	PAGE.
NOTABLE SPEED-TRIALS OF BRITISH LOCOMOTIVES.	<i>Charles Rous-Marten.</i> 87
With 19 Illustrations.	
RAILROAD FARES AND PASSENGER TRAVEL.	<i>H. G. Prout.</i> 206
THE DEVELOPMENT OF THE RAILWAYS OF CANADA.	<i>Walter E. Weyl.</i> 387
SOME FEATURES OF INDIAN RAILWAYS.	<i>J. W. Parry.</i> 558
With 10 Illustrations.	
THE UNDERGROUND RAILWAYS OF LONDON.	<i>Frederick E. Cooper.</i> 928
With 17 Illustrations.	

REVIEWS.

Ballast, Tests of Railway.....	320	Orleans Railway, The New Terminal of....	671
Compound Locomotives, Swiss.....	147	Progress, Railway.....	664
Compound Locomotives.....	492	Railway Business in Japan.....	316
Cross-Ties, Steel.....	495	Steel Cross-Ties.....	495
Japan, Railway Business in.....	316	Swiss Compound Locomotive.....	147
Jungfrau Railway.....	669	Terminal of Orleans Railway, The New....	671
Niagara Railway Arch.....	475	Transport Facilities, Improvements in.....	138

INDEX to leading articles on Railway Affairs in the Engineering Press, including New Construction, Maintenance of Way, Terminals and Yards, Transportation, and Miscellany 182, 355, 529, 702, 880, 1067.

STREET AND ELECTRIC TRAMWAYS.

		PAGE.
THE GROUND CURRENT OF ELECTRIC RAILWAYS.	<i>Albert B. Herrick.</i>	451
With 4 Illustrations.		
THE APPLICATION OF ALTERNATING CURRENTS TO		
ELECTRIC TRACTION	<i>Charles Henry Davis.</i>	811
	<i>Howard C. Forbes.</i>	972
With 10 Illustrations.		
THE UNDERGROUND RAILWAYS OF LONDON.	<i>Frederick E. Cooper.</i>	928
With 17 Illustrations.		

REVIEWS.

Electric Mountain Roads.....	137	Overhead Trolley, Sliding.....	314
Electric Traction, Engines for.....	137	Paris Exposition, Transportation at the.....	1040
Electric Traction, Progress of.....	489	Sliding Overhead Trolley.....	314
Engines for Electric Traction.....	137	Traction, Engines for Electric.....	137
London Railway, Central.....	314	Trolley, Sliding Overhead.....	314
Mountain Roads, Electric.....	137		

INDEX to leading articles on Street and Electric Tramways in the Engineering Press, 185, 358, 532, 705, 885, 1069.

BOOKS RECEIVED AND REVIEWED.

Notices under these heads appear on Pages..... 187, 534, 707, 886.

THE
ENGINEERING MAGAZINE

VOL. XV.

APRIL, 1898.

No. 1.

THE SHIFTING SITE OF NATIONAL INDUSTRIAL
SUPREMACY.

By J. Stephen Jeans.

WE cannot better determine the most likely course of the iron trade of the future than by seeking to ascertain and to apply the experience of the past. What, for more than half a century, has kept Great Britain in the front of this industry? What of late years has placed the United States in the position formerly occupied by Great Britain?

Industrial supremacy is largely a function of the character of the population. If the people of India or China were as competent, from an industrial point of view, as England or the United States, there could be no question as to the race with which ultimate supremacy would lie, assuming the possibility of maintaining the conditions otherwise the same. All production is more or less a function of labour, and as the nominal cost of labour in eastern countries is about one-twelfth the cost in the industrial centres of the United States, the race should be to the "Chinese cheap labour," if it were sufficiently effective. As it is, however, oriental labour has not come to the front for metal working to any extent worth speaking of, although it has made vast strides in textile industries, and we are consequently unable to compute the ultimate issues involved in its application to mining and metallurgy. Arguing from the known to the unknown, we can here add only that nominally dear labour is often the cheapest, and the paradox remains that the most highly-paid labour in the world on a large scale is able to turn out the cheapest work.

I delayed the completion of this summation of my recent articles in THE ENGINEERING MAGAZINE on "Supremacy in the Iron Market,"

Copyright, 1898, by John R. Dunlap.

until I was in a position to estimate the consequences of the very serious strike that has for the last thirty weeks been raging in the engineering industry of the United Kingdom. If Great Britain has suffered more loss to her industrial prestige from one cause than another, that cause is the influence and action of the trade unions, whose guiding principle has been to turn out the smallest possible amount of work at the highest possible cost, and which are always seeking for concessions that are seldom sought or expected by the workmen of other countries. It is generally believed that the settlement of the engineering strike, announced January 28, will tend to put a check on the powers and demands of trade unions throughout the iron and engineering industries generally. If so, then I do not hesitate to say that a much brighter day for British manufacturing prospects will have dawned. No one who knows British labour as I do is likely to question its capacity, its skill, its doggedness, its power for producing really good work. The British workman has succeeded in making a high reputation for British manufactures in all parts of the world. I say nothing of the character of the industry of American workmen, but no Englishman need be afraid to compare his country's manufactures with those of any country in continental Europe, even if it is admitted that we are too prone to speak of German-made goods as "cheap and nasty."

The first element of success and supremacy in this as in most other important industries is the actual existence of a great demand for the manufactured products at home. It was undoubtedly this demand, more than any other single cause, which secured so large a command of the world's markets for the United Kingdom. It has been the home demand, also, more than any other single cause, or perhaps any combination of causes, that has built up the wonderful iron industry of the United States. The immediate effect of a large home demand is to bring many industrial establishments into existence, which compete with each other and with outside producers, in order that the cost of production may be brought low enough to leave a large competitive profit.

On the other hand, the absence of this large home demand has generally tended to keep the non-progressive countries to which it applies in a backward metallurgical condition, making the cost of manufactures expensive, and restricting the consumption by reason of the high prices of commodities. Take, as an example, the case of Russia. Although the population of that vast empire in 1880 was about a hundred millions, the actual production of pig iron in that year was not more than 465,000 tons, of finished iron 292,000 tons, and of steel 307,000 tons, whereas, in the same year, the United States, then a comparatively undeveloped country, produced nearly

four million tons of pig iron, and almost three million tons of finished, or semi-finished, products. The one country—it matters little how or why—was bent on a large and rapid development of its resources; the other was passive and inert, merely perhaps because its time had not yet come. The natural consequences have been that the United States have done a great deal to improve the conditions of manufacture, whereas Russia has done but little, and that the one nation to-day enjoys an abundance of cheap iron and steel, whereas the other has to pay higher prices than any other civilized country over a very wide area, and imports larger quantities from other countries than does any other nation with relatively equal, or approximately equal, population, resources, and requirements.*

America, then, has obtained the lead in the world's iron trade, in consequence of her own extraordinary requirements, compelling the highest attainable economy to be achieved and placed at the disposal of consumers. Has anything been done in this direction by the United States that other countries cannot rival? Is it probable that the United States are possessed of natural resources so exceptional, and consequently of the "unearned increment" of economical production, that they are not likely to be seriously threatened by the competition of other and newer countries in the not far distant future?

My own investigations lead me to the conclusion that no single country has thus been endowed by nature, and that the mineral wealth of the world is distributed over so wide an area that no single country can hope to enjoy supremacy, in so widely-diffused an industry as that of the manufacture of iron and steel, for a long period,—long, that is, as periods go in the history of the world. It may be that to-day the industrial situation of the United States, or of the United Kingdom, looks impregnable, but it is always much less so than it appears to be. It is not many years since I was confronted with figures which appeared to prove with convincing relevancy, that the cost of the production of iron in Nova Scotia would be less than on any other part of the American continent. I enjoy a fairly considerable acquaintance with the mineral resources of New South Wales, thanks largely to information communicated by my friend, Mr. Mitchell, of Sydney,—who, in his former position of member of parliament there, and since, has strongly advocated the establishment of a local iron industry,—and it would not surprise me to learn that, with the iron-ore resources of Carlo's Gap, Picton, and other parts of the colony, and the large coal-fields near at hand, iron could be manufactured in that distant

* I ought to add perhaps that Russia is now making much more rapid progress. Her annual output of pig is 1,500,000 tons, and of steel about 700,000 tons.

colony as cheaply as in any part of the world. Then, again, every one is looking forward to the possibility of a considerable development, in the not distant future, of the mineral resources of British India, of China, of Siberia, and of Japan. So far as India is concerned, I have examined a number of the volumes of memoirs of the geological survey of that empire, and cannot fail to be struck with the evidence which they afford of vast mineral wealth, alike in coal and in iron ores, scattered with bountiful profusion over very wide areas. The demand for metals is not yet large enough in India to justify a large metallurgical industry, nor is it by any means certain that such a demand will speedily come about; but that, under suitable conditions, India could manufacture iron and steel cheaply scarcely admits of a doubt. Of China and Japan but little need be said, because, while both countries are at the present time engaged in building iron- and steel-works, no export trade from either is likely to be developed for many years.

Matters, however, are much more likely to ripen into a competitive trade in some European countries, and notably in Spain and Russia. I have received, within the last few days, a letter from my friend, Mr. Julio de Lazartigui, of Bilbao,—one of the most intelligent of Spaniards, and one of the best authorities on the iron ore resources of Spain,—in which he speaks of a project for making pig iron in the Asturias from rich ores that can be delivered at the furnaces for about 5s. per ton, using coal which is mined near Gijon, thirty or forty miles away. Already, at Bilbao, a certain amount of trade has been done in the export of pig iron made on the spot from local ores and imported coke. As 50 per-cent. ores can be delivered at the furnaces for 5s. per ton, it follows that the total cost of the ores used per ton of pig is not more than 10s., and, although the cost of imported (English) coke is high, this difficulty is being to some extent met by introducing Spanish fuel, which is somewhat cheaper, and could be made cheaper still, if the demand were large enough. I had the pleasure of going over a number of the Spanish iron- and steel-works only eighteen months ago, and I confess to having been surprised at their mechanical and economic circumstances. If Spanish coke of good quality can be delivered at either Bilbao, Arles, or Rinaldes at 16s. per ton, I can conceive of no good reason why pig iron, both hematite and basic,—for both descriptions of ore are available,—should not be made for 28s. per ton, at which rate it would be the cheapest pig iron in Europe, except that produced, on a comparatively small scale, under very exceptional conditions, by the Peine Iron Company, near Hanover, in Germany.

So far as Russia is concerned, it seems almost absurd to speak of an empire that is now importing about three-quarters of a million tons of

iron and steel annually from other countries as likely to enter the ranks of iron-competing countries within a period of time worth taking account of. As a matter of fact, however, Russia may be much nearer to the attainment of this position than is commonly supposed. One can only guess at some of the geographical and economic results that are likely to follow upon the opening of the trans-Siberian railway. It is well known that Siberia is a country rich in minerals of every kind, and, although the present population is almost ridiculously small for such a country,—being less than six millions, or not more than 1.2 per square mile,—still, the advent of railway facilities must make a momentous change in the relations of orient and occident. Leaving this for the moment, however, I happen to be aware of a project now on the *tapis* for erecting large iron and steel works between the Caspian and the Black seas, which are intended to supply the requirements of a large part of Turkey and Persia, as well as of a certain area in Russian territory, now insufficiently provided for; and in one or two other centres aggressive ideas begin to be entertained.

Probably enough has been said to justify my argument that the future supremacy of any one country in the iron markets of the world cannot be guaranteed, because of the constant shifting of the conditions needed to guarantee such permanence.

Iron has been described as one of the most widely diffused of all the metals, and it is well that it is so, because no other metal is so much in demand. The present annual output of pig iron throughout the world is about 32,000,000 tons; in 1880, it was only about 18,000,000 tons; in 1870 only 12,000,000 tons; and in 1850 less than 5,000,000 tons. If the same rate of increase is maintained in the future, our annual consumption of pig iron in 1916 will be 46,000,000 tons, and in 1934—a date within the probable existence of most of the young engineers and metallurgists now living—it will be more than 60,000,000 tons.

If this enormous output should be called for, how and whence is it likely to be supplied? Is there any man conversant with the conditions of the world's iron manufacture bold enough to even hazard a conjecture, at the present time, as to where we might obtain an additional fifty million tons of iron ore annually, which would be called for by the iron consumption of thirty-six years hence, on the hypothesis just stated? This, be it remembered, would be an excess on present demands to the extent of almost as much again, and nearly three times the present actual consumption of the United States.

What countries are likely to make the largest contributions to this stock? Certainly Great Britain cannot do a great deal more than maintain her present output of nearly 15,000,000 tons annually. Ger-

many is in no better case, although she has Luxembourg and Lorraine to depend upon. France has not for many years succeeded in producing more than 3,500,000 tons annually, despite the large deposits of the Meurthe-et-Moselle,—a district which I have, within the last fortnight, had the pleasure of visiting. The future supremacy of the world's markets, all other things being equal, must, therefore, clearly lie with the country that can make the largest contribution towards this hypothetical quantity. Will that country be the United States? If so, to what extent can the United States furnish the difference? Are the supplies of the Lake Superior range practically inexhaustible? If not, how soon are they likely to be exhausted, if, as is probable, the drain upon them should be doubled during the next twenty years? And, if the Lake Superior ranges are near depletion, what other sources of supply can the republic muster? The solution of these several problems must involve large and probably totally unexpected changes within the next quarter of a century,—changes that call for all the discernment, foresight, and prevision at the command of those who are now engaged in the world's iron industry.

I hope that in what I have just written I may not be misunderstood. I quite realize the probability that the growth of the demand for iron may not in the future show the same progress—either arithmetical or geometrical—as in the past; and I need hardly add that all analogy and experience should prove that, whatever the increase of demand may be, it is certain to be supplied from some quarter. It may be that Pittsburg and Sheffield may some day be conquered in the Congo or in New Caledonia. But, however this may be, there is an element of uncertainty about the whole matter that should make us careful about obvious dogmatising in the face of so much obscurity.

Nor should we lose sight of the fact that a plentiful supply of minerals is not the one thing needful to industrial preëminence; otherwise the present *situs* of the iron industry would not be in Pittsburg and Chicago, Middlesboro and Sheffield, but in localities or countries that are as yet almost in the wilderness. Many other conditions are important, and even essential. A skilled and industrious population is especially necessary. Such a population is found in the United States, Great Britain, and one or two other civilized countries. It is rarely to be found in countries which, like Russia, are only semi-civilized, or in countries which, like Spain, have fallen back in the race for national preferment.

Now, if the unquestionable efficiency of the British workman, when on his mettle, is for the future to be allied—as it is hoped it may be—to a greater willingness to adopt what are called American methods,—in other words, to speed up machinery to its utmost, and

to run all capable plants for what they are worth,—it seems to me that the change will greatly modify the conditions that have prevailed in the past, and do prevail at present. It is to be assumed that in the best American works there is now little or no unexhausted reserve of force,—in other words, that the man and his work are employed to their utmost tension ; but this is by no means the case in the majority of British works. On the contrary, it may be admitted that, to bring up these works to the highest efficiency known in American practice, there is probably an unexhausted margin of thirty to sixty per cent. to work upon. Will this margin be made use of? If so, to what extent? Our practice, as I have pointed out before, is steadily improving, alike in iron-making and in steel-manufacturing, but there is still much to be done. I am glad to be able to add that our leading works have narrowed the margin very much, even within the last year.

The Dowlais-Cardiff works in South Wales constitute a record establishment. The Barrow works have lately reorganized their bessemer plant, using 20-ton converters, and their labour costs per ton of ingots or rails will probably compare favourably with any in the United States. The great works of Bolckow, Vaughan & Co. have expended a large sum of money in supplying a larger amount of blowing power and in other improvements, so that they now command perhaps twice the volume of blast that they formerly had. Our open-hearth steel works, which are equal to an output of nearly three million tons of steel annually, are steadily improving their mechanical equipment, and can now produce steel plates for perhaps a third part of the labour cost of only a few years ago. The old country, depend upon it, has a great deal of “kick” left yet, and, among the many surprises which the iron trade of the future has in store, it is perfectly conceivable that one may be a resurrection of British supremacy on a scale that no one hardly dares to dream of at the present time, because John Bull is a pronounced pessimist, and rarely magnifies his industrial prowess or achievements, as is common in some other countries. I hope I am not an industrial Jingo ; but, when one reflects that Great Britain has everything, excepting unlimited supplies of certain ores, within her own borders, and that she has the wide world over which to range in search of supplies,—which she must command on more favourable terms than any other country,—it is hardly likely that she is about to suffer much eclipse, *with fair competitive conditions*. Of course, the conditions that have recently prevailed have not been fair, and have given England but little chance. Her chief competitors—Germany and the United States—have more or less kept up prices at home, by pools, syndicates, or otherwise, and have dumped their surplus produce upon neutral markets, hitherto fairly occupied by Great

Britain, on terms that could not have been offered with profit, had they been depended on, as British terms always are, for dividends.

In one important condition affecting competition, apart from natural resources and efficient labour, there has been a wide difference in the past between the chief competing countries of the world, which is not likely to be perpetuated to the same extent in the future. I refer to the influence on cost of production exerted by the action of the State. The effect of legislation in the increased cost of producing coal has been very serious in Great Britain, authoritative estimates having placed it at 1s. 3d. to 1s. 6d. per ton. In Germany the effect of the introduction of the system of workmen's compensation for accidents has been to greatly increase the burdens on industry, the average of some large works being as much as 4 to 5 per cent. on the total amount of wages paid. One large concern that I have visited in Westphalia has paid as much as £25,500 in rates, taxes, and State obligations on a capital of only £800,000, and a *personel* of 11,313. In Great Britain the Workmen's Compensation Act of last year will come into operation on July 1, and will lead to similar results, although probably not to so serious an extent. Hitherto the United States have kept comparatively free from such burdens, as well as from the more serious burdens of conscription and the maintenance of a large standing army. Will this continue to be the case in the future? Will the United States continue to be as free from war burdens as hitherto, relatively to other countries? If the United States were "on an even keel" with European countries in these respects, the balance-sheets of manufacturing firms would in some cases be likely to show very different results. As it is, it is notorious that comparatively few of the leading American iron-making corporations have been making large profits, and that some of them have incurred heavy losses. I am aware that there are notable exceptions,—or, rather, one notable exception, that has made really handsome profits, due to an efficiency of administration and a singleness of purpose rarely equalled in manufacturing annals.

I am only too well aware that I have but touched the fringe of a very large subject. But even so, I venture to hope that the facts and suggestions submitted may have tended to shed an increased light on what is unquestionably one of the most important questions of the day, the settlement of which must largely affect the prosperity of large parts of the world's surface, both now and in the distant future.

ERRATA.—Owing to my having been unable to revise the proofs, several clerical errors crept into my article in the issue of December, 1897. At p. 400, line 10, the cost of the Meurthe-et-Moselle ores should have been stated at 2s. per ton, and on p. 401, line 21 from bottom, the word "less" should have read "more."

EUROPEAN SEA-GOING DREDGES AND DEEP-WATER DREDGING.

By E. L. Corthell.

I.—TYPES OF APPARATUS AND COSTS OF OPERATION.

THE commercial requirements of the last half century, the competition of country with country, route with route, port with port, rail with water, all over the civilized world, have made it more and more important to supplement natural forces by artificial appliances, in order to remove the obstructions to a commerce increasing so rapidly in tonnage and size of carriers.

The vast benefits to commerce conferred by the mechanical ingenuity of man, producing great and economical tools for this important work, can scarcely be over-estimated.

To one at all familiar with the existing conditions in the United States and Europe, a great contrast is apparent. The former country, although possessing an extensive line of sandy coast (nearly all sand, except in a few localities), a coast indented with bays and supplied with estuaries and rivers penetrating often far into the interior, and capable of great commercial development, has, in spite of all these favorable conditions, done comparatively little to improve them.

There is scarcely one large manufactory of dredging-plant in the whole country prepared to build modern, effective, sea-going dredges. Most of those built are of the inland type, dipper or clam-shell or mud pumps. The backwardness and lack of suitable sea-going dredges and of manufacturing plant correspond remarkably well with the lack of harbor terminal facilities so ably shown by Mr. Crowell in recent numbers of *THE ENGINEERING MAGAZINE*.

The attention of the army engineers who have charge of river and harbor improvement in the United States has of late years been given to the subject, and the government no doubt will have at command, in course of time, dredges comparing favorably with those manufactured in Europe. The Mississippi river commission is also working to meet the requirements on that important river, where it has been found necessary to supplement works by dredging in order to supply commerce with the depth needed for navigation at low water.

There is one suction-dredger in the United States which deserves mention. In 1876 Mr. Jas. B. Eads, then engaged in building jetties at the mouth of the south pass of the Mississippi river for the purpose of deepening the channel from 9 feet to 30 feet through the bar lying outside in the Gulf of Mexico, designed *de novo* a powerful

dredger, which, though the hull was built at Pittsburg on the Ohio river, and consequently is not a sea-going dredger, is able to work in a considerable seaway, and has been to sea as far as Pensacola, Florida, to work on the sea bar there. This dredger was at the time one of the largest in the world, and had one of the largest centrifugal pumps, 6 feet in diameter with an inlet pipe 30 inches in diameter. It carried its own dredgings to sea in hoppers in the hull holding about 500 cubic yards. In free material, and with the depositing ground not more than two miles distant, it could dredge in ten working hours about 5,000 cubic yards of solid matters, and deposit them.

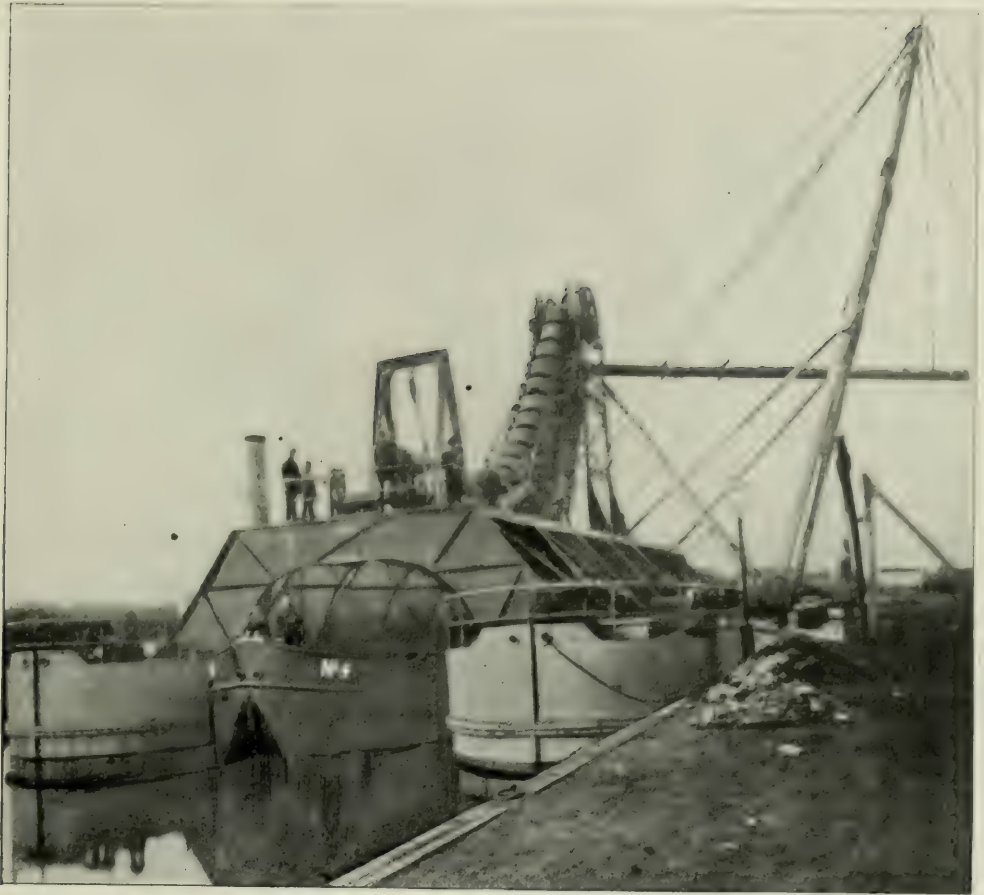
The purpose of this dredger was not to excavate the channel, but to hasten a development going forward by natural forces, which the jetties were bringing to bear upon the bar. It is a fact that, of all the material removed to make the channel, the dredge-boat removed less than one per cent. This boat has now been in use more than twenty years, not enlarging, but rectifying or shaping, the channel to conform to the three dimensions of the law,—*viz.*, 26 feet deep below average flood tide (the average range of tide is only 14 inches), with a width at that depth of 200 feet and a central depth of 30 feet.

Although there is not, as stated above, any manufacturing plant in the United States engaged in building over-sea dredges, the present customs law practically prohibits the introduction of these from any other country, the duty being 45 per cent. *ad valorem*. It has even been decided to be against the law to send a dredge-boat up from a Mexican port to do any work at any of the gulf ports of the United States, without paying this heavy duty. Consequently, being debarred from the use of any foreign dredges or from building any in foreign yards, the engineers, contractors, railway companies, ports, and the government itself, must simply go without them.

It is my purpose here to give briefly (1) the history of dredging and dredging appliances; (2) descriptions and illustrations of some characteristic dredges of the various types, and of their use, way of handling, capacity, and output, and some idea of the extensive use of dredges in Europe, and in countries dependent upon European manufacturers for dredging appliances; (3) the cost of dredging under varying conditions; (4) the conditions under which dredging has been successful from physical, economical, and commercial points of view, and, conversely, when it has been, or would be, unsuccessful; (5) some instances of the commercial benefits of dredging.

HISTORICAL DEVELOPMENT.

We can find an example of dredging as far back as 1591. This appears to be the earliest recorded. It consisted of two pontoons lashed together, yet held far enough apart to allow two spoons to



FLOATING ELEVATOR WITH LONG DELIVERY SHOOT.

Supplied to the Sanitary Works of Paris in 1887 by the Ship-Building and Engineering Co.
"Werf Conrad," Ltd., Haarlem, Holland.

work in opposite directions. Iron buckets were first attached to an endless chain in about 1750, in raising material from foundations at Dieppe and for a bridge at Orleans.

In 1797 Boulton and Watt applied a steam engine to a dredger, to clean out the harbor of Sunderland. This was a very small affair, but was a precursor of much more powerful dredgers. The engine was only of four h. p., and was placed in a flat-bottomed scow about 60 feet long, 20 feet wide, and 6 feet deep, with a draft of 4 feet. The engine and all the machinery weighed only 23 tons. It worked four spoons, each of which would raise a ton 10 feet in one minute.

Well-known engineers, such as Trevithick and Rennie, figure in the development of the dredge, for in 1802 the latter made some improvements on an appliance previously invented by the former; but in 1806 the former was bold enough to enter into a contract with the Trinity Board to remove 500,000 cubic yards per annum for twenty-one years from the bed of the river Thames.

In 1861 two "hopper steamers" were built for use on the Clyde; each could carry 200 tons. In the same year, Messrs. Wm. Simons & Co., of Renfrew, constructed an iron screw-propelling hopper barge of 300 tons' capacity. This was the first "steam hopper barge."

Probably the first successful attempt at suction-dredging was on the construction of the Amsterdam canal in 1867, where a centrifugal pump was fitted to an old bucket dredge. A vertical shaft, driving a "spinner" 3 feet 6 inches in diameter was fitted near the bottom of an upright cylinder 12 feet high, so arranged that the contents of the buckets falling through it were met by the ascending column of water from the centrifugal pump. This liquefied the silt, and it was forced to the shore through wooden pipes placed on buoys, or floats. These pipes were connected by leather joints, or sleeves. This machine could deposit, at a point 1,200 feet distant, 2,000 tons of solid matter to a height of 8 feet above water-surface in 12 hours. Three years later double machines of this kind were used on canal work at Cronstadt, Russia. Attached to the vertical shaft of this machine, however, were water jets under high pressure, which were directed into the cylinder. By this means stiff clay could be sufficiently broken up to be moved ashore. This kind of machine was afterwards employed on the Danube.

Ten years later (1880) a combined bucket and pump dredger was built in England. This came nearer to the dimensions of more modern dredgers. It was 124 feet long, and 28 feet beam, and the buckets held 18 cubic feet. It would dredge to a depth of 28 feet. The



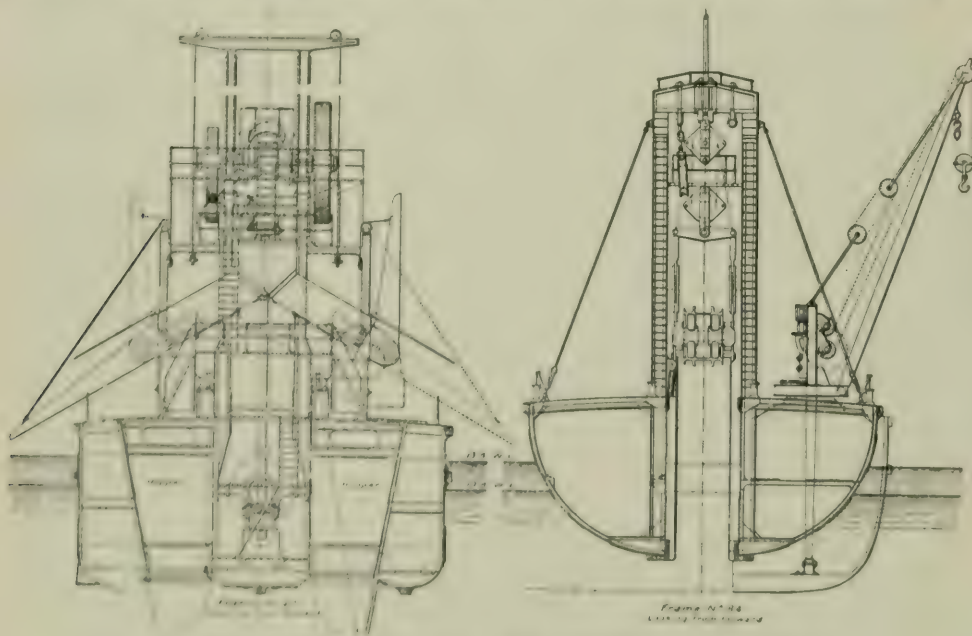
COMBINED BUCKET AND SAND PUMP DREDGE "VOLSHSKAIA."

138x23x9 ft., combined lifting capacity per hour, in free soil, 9,180 cu. ft.; Wm. Simons & Co., Ltd., Renfrew.

centrifugal pump was 4 feet 6 inches in diameter, and the discharge pipe 18 inches. The suction pump dredger was next applied to steam hopper barges, and used at the ports of Rotterdam and Amsterdam. Such barges were then, in many places, fitted with suction pumps.

TYPES AND THEIR USE.

(1) Bucket dredgers, with single and double ladders, and buckets of various sizes and kinds, working on an endless belt, the bucket ladder working in some cases through a bow-well, in others through a stern-well: (*a*) loading into barges alongside; (*b*) loading into their own hoppers in the hull of the boats, or into barges alongside (then styled a "hopper bucket dredger"); (*c*) discharging into a hopper on top, at the summit of the run of endless belt, where a jet



CROSS SECTIONS OF THE SOLID ROCK DREDGER "MAJESTIC."

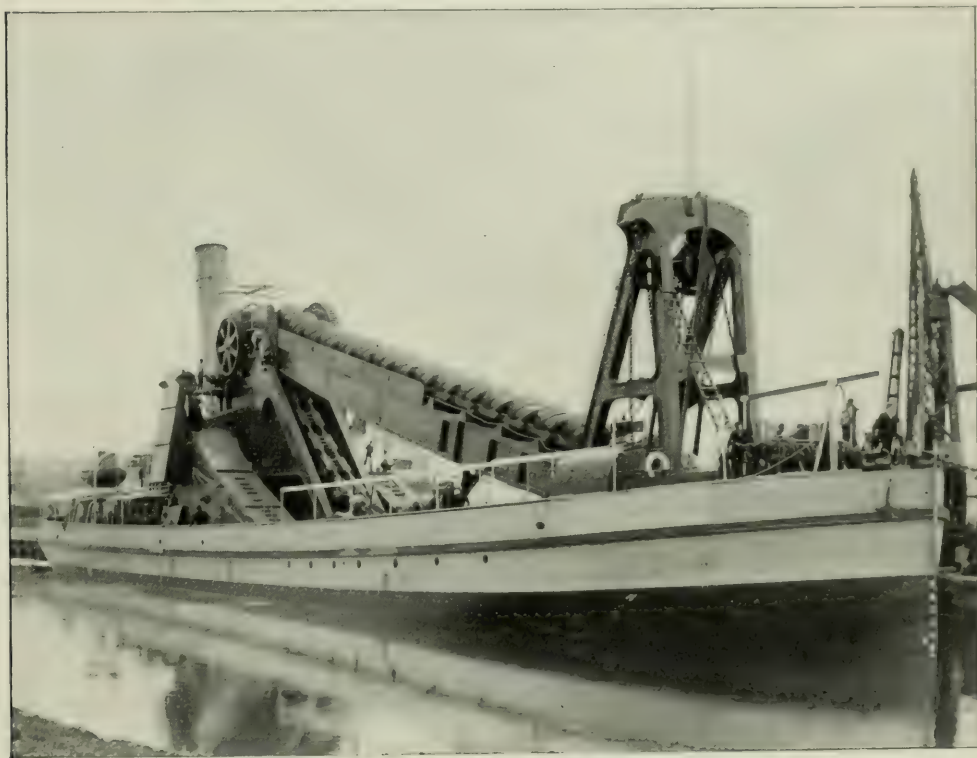
of water from a pump lubricates the material and forces it into long shoots or pipes, which are supported from a mast and reach over the banks ashore, where, by an extension of its pipes, the material is carried a considerable distance and deposited on the land. The height of this elevated hopper is sometimes more than 60 feet above the deck of the boat. Some very powerful dredgers of this kind were used on the Panama canal by the American Dredging Company, and these were built at Jersey City, opposite New York. Several great dredgers of this kind were used by Messrs. Pearson & Sons on the drainage canal of the City of Mexico, and they have been used extensively on the Rotterdam waterway and elsewhere.

(2) Sand pump dredgers. These are either barge loading or hopper



BARGE-LOADING DREDGE "MELBOURNE."

200x35x11½ ft.; lifting capacity per hour, in free soil, 18,750 cu. ft.; maximum depth dredged, 35 ft.; Wm. Simons & Co., Ltd., Renfrew.



HOPPER AND BARGE LOADING DREDGE "SIR JOHN GOODE."

210x40x15 ft.; hopper-capacity, 19,000 cu. ft.; lifting capacity per hour, in free soil, 17,400 cu. ft.; Wm. Simons & Co., Ltd., Renfrew.

dredgers. Some have two pumps and two suction pipes; others, one only. Some are for inland work, and some are seagoing.

(3) Combined bucket and sand pump hoppers: generally seagoing, and for ports or mouths of rivers where there is a variety of materials, some of which are more easily moved by the buckets and some by the pump; the former, generally clayey materials, the latter soft mud and sandy materials. Soft mud is easily removed by the pump; but, on account of its very light specific gravity and great fineness, it settles so slowly in the hoppers that a great deal of it is wasted overboard through the overflow weirs.

(4) Mud pump. This is an apparatus for sending ashore, under the force of a strong water pump, material which has been raised by a



DREDGER WITH LONG SHOOT, "LA CRAU."

Built in 1881 for the drainage works of the Marais de Fos, southern France, by the Ship-Building and Engineering Co. "Werf Conrad," Ltd., Haarlem, Holland.

bucket or suction dredger, the mud pump being usually placed alongside the dredger, or taking the material out of a barge alongside.

(5) Grab bucket hopper. This is usually a sea-going vessel for depositing from its own hoppers, and may have two, four, or more grabs of the Priestman, or clam shell, class. These grabs are worked by cranes which swing outboard, drop the grab to the bottom, and then, raising it loaded, drop the contents into the hoppers.

(6) Hopper barges, into which material is deposited from a bucket dredger or sand pump, when it is towed to sea by a tug, which may take one or more barges in tow.

(7) Hopper steamer, a hopper barge with its own propelling power. The material is deposited in its hoppers by a bucket or sand pump dredger; it takes the load to sea, and discharges it.



SAND-PUMP HOPPER DREDGE "WALRUS."

210x36½x15½ ft. ; hopper-capacity, 26,000 cu. ft. ; lifting capacity per hour, in free soil, 48,000 cu. ft. ; Wm. Simons & Co., Ltd., Renfrew, Scotland.



COMBINED BUCKET AND SAND-PUMP DREDGE "NO. 10."

138x25x9 ft. ; hopper-capacity, 25,180 cu. ft. ; lifting capacity, per hour, in free soil, pump, 10,750 cu. ft., buckets, 20,900 cu. ft. Wm. Simons & Co., Ltd., Renfrew.



GRAB-BUCKET HOPPER DREDGE "NO. 76."

110x23x9½ ft.; hopper-capacity, 3,300 cu. ft.; lifting capacity per hour, in free soil, 3,050 cu. ft.
Wm. Simons & Co., Ltd., Renfrew, Scotland.

There are peculiar and interesting modifications and varieties of nearly all these principal classes forming special types. There are bucket dredgers with transporting belt to carry the material ashore. Many of the bucket dredgers are dismountable for ocean voyages. There are floating elevators which are anchored in the stream or near the banks of a river, and the barges of material dredged by some other method elsewhere are brought alongside, when the elevator redredges out of these barges, and delivers the material ashore, often at a considerable distance. There are even stationary elevators on piling or trestle work for the same purpose, and the barges in such cases have no bottom doors, the material being dredged out of their holds.

To the above classes should be added the ordinary single dipper and clam-shell dredges so largely used in the United States, and the Priestman dredger, on the same general principle. The powerful dipper and Priestman dredgers on the improvement at and near the "Iron Gates" of the lower Danube did, and are doing, good work in removing the *debris* of the blasting operations at the rocky bottom, though the most effective machines there are the great ladder bucket dredgers designed especially for handling large masses of broken rock in the swift currents of the Danube.

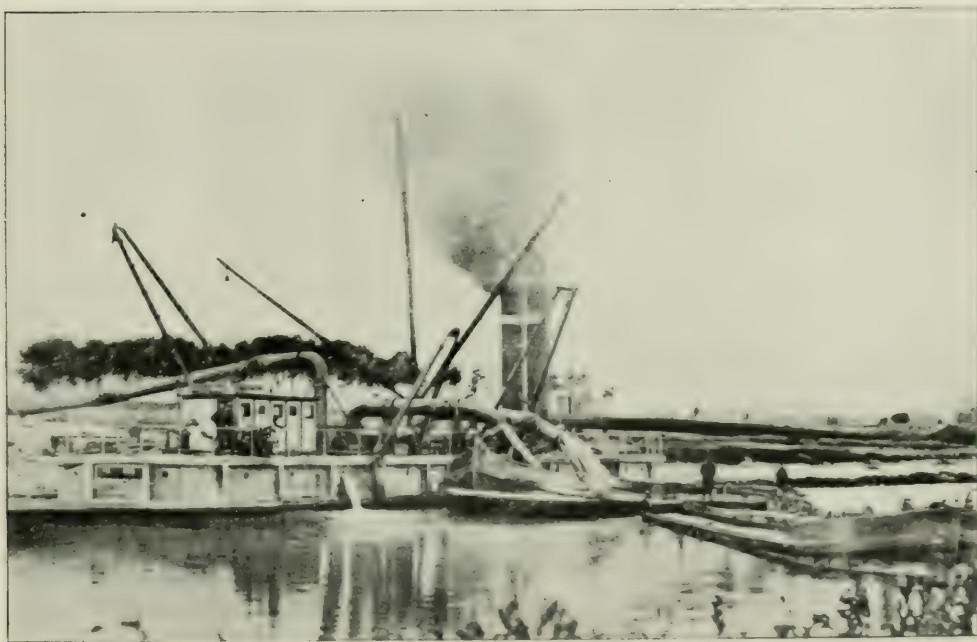
EXAMPLES OF DREDGERS.

The writer has been able to present illustrations in the way of photographs, through the courtesy of two of the leading manufacturing companies of Europe, Messrs. Wm. Simons & Co., Ltd., of Ren-

frew, Scotland, and the "Werf Conrad" Company, of Haarlem, Holland. There are other well known manufacturers, like Lobnitz & Co., of Renfrew, and J. Smit & Son, of Kinderdijk, Holland, whose output has been very great, and who are known all over the world. By special request Messrs. Simons & Co. presented the writer with many photographs of characteristic dredgers, and a tabulated statement, giving some of the more important particulars.

During thirty-two years Wm. Simons & Co. have constructed dredgers of a great variety of types, for eighteen governments, thirty-two companies and harbor boards, and ten railway companies. The dredgers were destined for seventy eight different places. An analysis of the list of dredgers built gives 36 barge-loading bucket dredgers; 71 bucket hopper dredges, either bow-well or stern-well, six of which were fitted with sand pumps; 12 sand-pump hopper dredgers; and 62 steam hopper barges. The Werf Conrad Co., in thirteen years, have built 61 bucket dredgers, of which 30 were supplied with mud pumps; 24 sand pump dredgers, of which 15 were supplied with mud pumps; 6 mud pumps; 5 elevator dredgers; 3 excavators; and 69 hopper barges. These were built for forty-five contracting companies, three railway companies, nine harbor boards, one city, and five governments. They were used in twenty-one different countries.

The list of large dredgers would not be complete without a brief reference to the two largest in the world, designed for and now working on the Liverpool bar, eleven miles at sea. The description of one



PUMP DREDGER FOR EMPTYING BARGES.

Built by the Ship Building and Engineering Co. "Werf Conrad," Ltd., Haarlem, Holland.



SAND-PUMP HOPPER DREDGE "OCTOPUS."

215x36½x15¾ ft.; hopper-capacity, 1,300 tons; lifting capacity per hour, 3,000 tons of sand;
Wm. Simons & Co., Ltd., Renfrew.

will fit the other, with some minor exceptions. The hull is 320 feet by 47 feet by 20½ feet deep. The loaded draft is 16 feet. There are two centrifugal pumps, each 6 feet in diameter. Each has a 36-inch pipe. These unite into a 45-inch pipe hung by a ball and socket joint on a trunnion, so as to work safely in a seaway when waves are 10 feet high. This suction pipe is 76 feet long, so as to allow dredging in 53 feet of water. There are eight hoppers, holding in all 3,000 tons of material, equivalent, when solid, to about 2,000 cubic yards. The hoppers can be filled with solid matter in three-quarters of an hour, and the load can be discharged in five minutes. These and companion dredgers have moved from this sea-bar more than 17,000,000 cubic yards of solid earth. The dredgers cost about £36,000 each.

Some details of another and somewhat similar dredger will be of interest. One of the most effective sand pump hopper dredgers is the "Octopus" (see photograph), built by Wm. Simons & Co., and a duplicate dredger of the same style and size, used at the same place (Natal, South Africa) and in the entrance to Durban Harbor, which is exposed to sudden and damaging silting-up outside the jetties. The vessel is 215 feet long, 36 feet 6 inches in breadth, and 15 feet 9 inches in depth, and the hopper has a capacity of 1,300 tons. The two centrifugal sand pumps, 33 inches in diameter, will raise 3,000 tons of sand per hour, working to a depth of 40 feet under water level. The sea bar at Durban shoaled up in a storm to a depth of 5 feet in

the south channel. The Octopus in three days (really fourteen hours' working time) dredged a channel through to water 13 feet deep at low tide, discharging, however, most of the spoil over the side.

THE COST OF DREDGING.

This varies as the conditions vary, and they are almost infinite. Referring first to the Liverpool sand pump dredgers described above, the facts are as follows. The sand dredged weighs about 124 pounds per cubic foot. Sixty per cent. of the mass drawn up is solid sand. The cost of pumping it, carrying it four miles to sea, discharging it, and returning it to the dredging ground is $1\frac{1}{2}$ cents per ton,— $2\frac{1}{3}$ cents per cubic yard,—counting everything except interest and depreciation of plant. The cost of dredging with the "Octopus," also described above, is about $1\frac{1}{2}$ d. per ton, or $2\frac{1}{4}$ d. per cubic yard, working in free sand and depositing the dredgings from one to two miles at sea. This cost includes insurance, interest on cost, and maintenance. The writer has obtained a consensus of opinion as to the cost of dredging by bucket dredgers under ordinary and favorable conditions. The average is about as follows:

Barge loading dredger, dredging in free soil (raising only), average cost say 10s. (\$2.43) per 100 cubic yards, including working expenses, wages of crew, coal and stores, and repairs (5 per cent. on capital).

Steam hopper barges (hopper steamers), con-

veying the spoil about eight miles to sea . . $2\frac{1}{4}$ d. per cubic yd.

Add dredging-cost by barge-loading dredger 1d. " " "

$3\frac{1}{4}$ d. ($6\frac{1}{2}$ c.) " "



BUCKET DREDGER WITH MUD PUMP.

Built by the Ship-Building and Engineering Co. "Werf Conrad," Ltd., Haarlem, Holland.

say 32s. 6d. (\$7.90) per 100 cubic yards for dredging by barge-loading dredger and depositing by steam hopper barge.

Hopper dredger, dredging and conveying the spoil about eight miles to sea, 2½d. (5c.) per cubic yard, say 25s. (\$6.08) per 100 cubic yards.

"No. 344" Grab Crane, named "Miles K. Burton" (see page 24), raised and deposited at sea at Liverpool eleven loads of about 1,450 tons each—15,950 tons (one load removed each tide), with double shift of hands. Her working expenses, for wages of crew, fuel, and stores, were less than 1d. per ton, or 1½d. per cubic yard, of spoil raised, and discharged twelve to fifteen miles off at sea. This dredger is equipped with five hydraulic cranes furnished by Armstrong's. The grabs worked by them are "Morgan's" patent, somewhat similar to Priestman's, with improvements.

In the river above and below Rotterdam the total cost of suction (sand pump) dredging, as per the contractor's price, is about 1.9d. per cubic yard. This is done with hopper barges, with a distance to dumping-ground of 3½ to 4 miles. Some of these dredgers have a large output, one of them handling, in a contractor's day, 6,000 cubic meters—7,850 cubic yards.

At Ymuiden, the harbor of the Amsterdam canal at the North sea, where about 700,000 cubic yards are annually dredged,—some in the sea, some in the approach to the locks, but mostly in the harbor channel,—the cost is about 5d. per cubic yard; but one cause of the larger cost is the inability to work at all times on account of the waves. The above is for dredging simply; if transporting, interest, and depreciation be included, the cost is increased as follows:

By bucket dredger, 4.63d.	} 8.33d. (16½c) per cubic yard.
Transport 2 miles, 3.70d.	

By sand pump dredger, 3.65d.	} 7¼d. (14½c.) per cubic yard.
Transport, 3.59d.	

At the Hook of Holland about the same amount of dredging is required outside and in the jetty channel, and the cost is about the same; both bucket and suction dredgers are used in both harbors.

In the river Tyne, from Newcastle-on-Tyne to Tynemouth, where, since 1838, about 100,000,000 tons of material have been dredged, largely to deepen and widen the channel of the Tyne, the cost has averaged about 3.6d. per cubic yard, various kinds of dredgers being employed. On the river Tees, where also a large amount of dredging has been done, the cost averages about 4½d. per cubic yard.

In the Belfast new channel, with bucket hopper dredgers, where 5,000,000 cubic yards were removed, the cost was about 3d. per cubic yard, including interest and depreciation. The depositing ground

was ten miles distant. The average cost, with hopper bucket dredgers in mud, sand, clay, and some stiff material, at Bombay, Blyth (east coast of Scotland), Belfast, and the Clyde, with an average transportation of nine miles, is $4\frac{3}{4}$ d. per cubic yard.

At Sydney, a suction dredge, forcing sand ashore 1,800 feet and mud twice that distance, dredged more than 2,000,000 tons at a cost of less than $2\frac{1}{2}$ d. or $3\frac{3}{4}$ d. per cubic yard; and another, which dredged about 2,500,000 tons, did work under similar conditions for 2d. per ton, or 3d. per cubic yard.

At Calais and Boulogne, suction hopper dredges, dumping two miles at sea, dredge at a cost of $2\frac{1}{2}$ d. per cubic yard at the former place, and $3\frac{1}{3}$ d. at the latter. This includes all expenses, except interest and depreciation. The analysis of cost of the Boulogne work is as follows: wages, 27 per cent.; coal, 28 per cent.; stores, 9 per cent.; repairs and maintenance, 36 per cent.

At Dunkirk, dumping three miles at sea, the cost is as follows, not including interest and depreciation:

By bucket dredges—

Dredging	1.93d.	} 3.93d. per cubic yard.
Transport	2.00d.	

By sand pump in the sea channel and $2\frac{1}{2}$ miles to dump
1.46d. per cubic yard.

To ascertain cost, including interest and depreciation, 10 per cent. is usually added. The analysis of this work is interesting.

Dredging:

	pence per cu. yd.	Transport.
Wages	0.527	0.216
Coal	0.264	0.119
Oil and sundries	0.184	0.025
Repairs	0.055	0.066
	1.030	0.426
Total (as above)	1.46d.	

On the Clyde, by bucket dredgers, transporting 7 miles in hopper barges: the dredging cost 2.54d.
the transport “ 2.47d.

5.01d. per cu. yd.,

including interest and depreciation.

One of the most effective and economical dredges is the Von Schmidt, named after the inventor and patentee, of San Francisco. Some very good work has recently been done by one of these dredges, embodying all the latest improvements of this type. A brief descrip-

tion will be of interest. It is called the "Groper," and is at Sydney, New South Wales. The hull is 115 feet by 50 feet by 9 feet; one end is square, the other semicircular. The pump, with a shrouded cast-iron "spinner" 7 feet 6 inches in diameter in a wrought-iron casing, has a speed of from 100 to 130 revolutions, according to the distance the materials are to be carried. The machinery for cutting the clay or other material is fixed on a strong platform, traversing on rollers from side to side of the dredge at the semi-circular end. The pump ascends at the center and outer end, and can move around horizontally with the travelling platform. The pipe is arranged telescopically for varying depth. Outside of it is a vertical shaft, to the lower end of which is attached a horizontal cutter 8 feet in diameter,



GRAB-BUCKET HOPPER DREDGE "MILES K. BURTON."

275 x 381 ft.; hopper capacity, 10,000 cu. ft.; lifting capacity per hour, in free soil, 25,500 cu. ft.; built by Wm. Simons & Co., Ltd., Renfrew, Scotland.

armed with steel knives. The material cut by these is swept up by the action of the pump, and forced on pontoons to the land. The writer of the article from which the above is abstracted states: "So effective is the cutting mechanism that a Von Schmidt dredge can cut its way into a bank 3 feet above high water, just as readily as it can deal with stiff clay, or even soft rock, at a depth of from 12 to 20 feet."

This dredge cost about £20,000, of which £8,000 was paid for the "Von Schmidt" pump and machinery and the royalty for using it. Much of the material is dumped alongside the dredge from other dredges. The cost according to distance ashore is 13½d. to 2½d. per ton. The average cost of all work at Sydney with pump dredges

PARTICULARS OF SOME CHARACTERISTIC BRITISH-BUILT DREDGES.

	NAME.	Yard No.	Class.	Dimensions.	Draft.	Hopper Capacity.	Max. Depth Dredged.	Lifting Capacity per hour in free soil. (cubic feet.)
1	Melbourne.	243	Barge Loading.	200' 0" X 35' 0" X 11' 6"	8' 0"	Finished	35' 0"	18,750
2	Francis Henty.	270	do	146' 6" X 32' 0" X 11' 6"	6' 6"	do	35' 0"	12,250
3	Lyster.	341	do	189' 9" X 35' 6" X 13' 0"	9' 9"	do	45' 0"	15,900
4	St. Austell.	330	do	192' 0" X 35' 6" X 13' 0"	8' 9"	do	46' 0"	16,100
5	Sir John Coode.	335	{ Hopper & Barge } Loading.	210' 0" X 40' 0" X 15' 0"	Light	Loaded.	36' 0"	17,400
6	St. Michael.	309	do	180' 0" X 36' 0" X 15' 6"	8' 8"	11' 6" 19,000 cu. ft.	45' 0"	9,500
7	Cornwall.	342	do	195' 6" X 37' 0" X 15' 6"	8' 6"	12' 6" 12,600 "	46' 0"	9,500
8	Mermaid.	280	do	191' 0" X 38' 0" X 15' 9"	8' 0"	12' 6" 13,200 "	35' 0"	12,680
9	Walrus.	346	Sand Pump Hopper.	210' 0" X 36' 6" X 15' 7"	8' 9"	13' 0" 26,000 "	35' 0"	48,000
10	Kate.	343	do	200' 0" X 39' 0" X 14' 6"	8' 0"	12' 0" 20,500 "	40' 0"	30,000
11	Jupiter.	297	do	160' 0" X 32' 0" X 11' 6"	6' 6"	10' 0" 12,300 "	35' 0"	21,000
12	No. 1.	300	do	145' 0" X 28' 0" X 12' 3"	5' 6"	10' 0" 11,200 "	35' 0"	9,600
13	Percy Sanderson.	319	Combined Bucket and Sand Pump Hopper.	220' 0" X 40' 0" X 17' 2"	8' 3"	13' 6" 25,180 "	35' 0"	10,750 Pump 20,900 Buckets
14	No. 1.	299	do	200' 0" X 46' 0" X 15' 0"	9' 6"	12' 6" 20,000 "	35' 0"	10,750 Pump 22,900 Buckets
15	No. 10.	318	do	187' 0" X 35' 6" X 14' 10"	8' 3"	11' 6" 14,300 "	35' 0"	14,450 Combined
16	Volshskaia.	320	Combined Bucket and Sand Pump.	137' 10" — 24' 8" X 9' 2"	3' 4"	Finished Nil	12' 6"	9,480 Combined
17	No. 76.	311	Grab Bucket Hopper.	110' 0" X 23' 0" X 9' 6"	5' 0"	7' 0" 3,300 cu. ft.	40' 0"	3,050
18	Miles K. Burton.	344	do	225' 0" X 38' 0" X 17' 0"	8' 6"	13' 6" 30,000 "	47' 0"	28,800
19	No. 21.	314	Hopper Steamer.	200' 0" X 35' 0" X 15' 6"	6' 6"	13' 6" 24,900 "		
20	No. 4.	336	do	155' 0" X 28' 6" X 12' 6"	5' 6"	9' 6" 10,300 "		

TABLE No. I.

	Work done in one year by two 650 ton Stern-Well Hopper Dredges (A and B).		Work done in one year by one Barge Loading Dredger (C) and three 600 ton Hopper Barges (D).	
	A.	B.	C.	D.
Number of days dredging.....	265	268	224	
Average number of hours per day.....	10 ¹ / ₄	10 ¹ / ₄	10 ¹ / ₄	10 ¹ / ₄
Number of crew	16	16	16	(40 in all.) 8 each.
Total quantity dredged and conveyed to sea.....	*386,410 tons	*336,500 tons	1676,053 tons for	dredger and barges.
Average per day.....	1,458 tons	1,255 tons	3036 tons	
Average time to load.....	1 ¹ / ₂ hours in soft material	Same as A	1 ¹ / ₂ hours in soft material	} to raise 500 tons.
	3 " hard "		3 " hard "	
Average cost per week for wages, coal, and stores.....	£94.3.9 (\$458.80)	for both dredges.	£95.14.6 (\$466.20)	for dredger and barges.
Average cost per week for wages, coal, stores, and repairs.....	£114.15.6 (\$558.90)	for both dredges.	£125.13.5 (\$612.00)	for dredger and barges.
Cost per ton of material dredged and conveyed to sea.....	1.981d (4c) per ton,	or 3d (6c) per cu. yd.	2.172d (4.33c) per ton,	or 3.25d (65c) per cu. yd.
Cost per ton of material dredged and conveyed to sea, including 5 per cent. on capital.....	2.698d (5.4c) per ton,	or 4d (8c) per cu. yd.	3.062d (6c) per ton,	or 45d (9c) per cu. yd.

* Nearly the whole of this was *very hard* clay.

† About one-half of this was *free* soil, the remainder *earthy clay*.

TABLE No. II. DATA OF COSTS OF DREDGING, DERIVED FROM ACTUAL WORK.

in harbor, rivers, and channels, moving about 11,000,000 tons, was $2\frac{1}{2}$ d. per ton, or $3\frac{3}{4}$ d. per cubic yard.

At Oakland, where the Von Schmidt dredge is largely employed for deepening the harbor, the cost per cubic yard is about $3\frac{3}{4}$ d. per cubic yard. At the Sulina outlet of the Danube, in a new cut made to rectify the channel, 7,751,000 cubic yards were moved and put mostly on the land for $2\frac{1}{5}$ d. per cubic yard. This material included hard clay, heavy sea-sand, fine sand, and light silt. It was learned on this work that, when very hard clay was encountered and could be pumped ashore only with difficulty, increasing the speed of the pumps from 225 to 275 revolutions would move almost any material, and prevent it from settling in the pipes.

TYPE OF PLANT.	Place.	Distance material conveyed, miles.	Cost, excluding interest and depreciation.	Cost, including interest and depreciation.
Dredger "Clyde" and three 500-ton steam hoppers ¹	Port-Glasgow,	7 to 8		
Dredging				1.85
Depositing				1.83
Bucket ladder dredger and steam barges.....	Liverpool,	7 to 8	3.63	3.68
Bucket ladder dredger "Teredo" and three 460-ton steam barges ²	Bombay,	4 to 5	2.20	
Dipper dredger No. 9, 1000 tons ³	Liverpool,	7 to 8	1.78	
" " "Pholas," 500 " ⁴	Bombay,	4 to 5	4.10	
Hopper dredger No. 3, 850 " ⁵	Belfast,	10	1.92	3.27
" " No. 4, 850 " ⁶	"		1.80	3.15
" " "Forth," 800 " ⁷	Grangemouth,	18	2.00	
" " "Leven," 800 " ⁸	Blyth,	2	1.03	
" " "Kuphus," 1000 " ⁹	Bombay,	4 to 5	1.50	

¹ A year's work. ² A year's work. ³ Day and night. ⁴ A year's work. ⁵ Over three years' work, day and night. ⁶ Over three years' work, day and night. ⁷ Working tides. ⁸ Day and night. ⁹ A year's work.

PARTICULARS OF COST OF DREDGING.

Taken from a paper on "Dredging and Dredging Appliances," read March 26, 1889, before the Institution of Engineers and Shipbuilders in Scotland, by Mr. Andrew Brown.

Many other instances of cost of dredging might be given; but the above are sufficient to show that the average cost is so small that this artificial method of improving and maintaining channel and harbor depths may be reasonably resorted to, where the conditions are at all suitable. This leads to the consideration, which will be taken up in the next number of THE ENGINEERING MAGAZINE, of the conditions under which dredging has been successful from physical, economical, and commercial points of view; and, conversely, where it has been, or would be, unsuccessful.

SYSTEMS AND APPARATUS FOR HEATING BUILDINGS BY STEAM.

By J. J. Blackmore.

THE art of heating buildings by steam has progressed so rapidly during the past ten years that there are now three distinct systems well developed, all performing the same kind of service, but doing it under conditions that vary materially. The oldest and most widely known of these is the gravity system, so called for the reason that the steam generated in the boiler rises up to the radiators, and, as it is condensed, the resulting water is returned to the boiler by gravitation, no appliance, other than the return pipe, being used for this purpose.

The next is what may be called the mechanical system, as mechanical means are frequently applied to reduce the pressure of the steam in the system from that carried in the boiler, and mechanical appliances are always used to return the water of condensation from the return pipes of the system back to the boiler. These may be in the shape of an automatic steam trap, or a pump and governor, as may best suit the conditions.

The third is the exhaust-steam system, in which the heating is done by steam that has been used to drive engines or pumps, and that would be of no further service if it could not be utilized as heat. In this system mechanical appliances are also used for controlling and directing the steam through the system. These appliances are back pressure valves, for the purpose of preventing too much back pressure on the engines; separators, to remove the oil or other impurities carried over with the steam from the engine cylinders; and traps, or pumps, with governors, to return the water of condensation to the boilers. This article will deal only with the first mentioned,—the gravity system.

Steam heating by gravity is almost always by low pressure,—*i. e.*, at a pressure of less than ten pounds as indicated by steam gauge. This pressure is considered absolutely safe, and on that account very few States of the union have made any laws for the inspection or supervision of low-pressure steam boilers. A well-designed gravity steam-heating apparatus, unless of large dimensions, will operate perfectly without indicating any pressure on the steam gauge, the pressure of the atmosphere being sufficient to exert all the force necessary to distribute the steam to the various radiators in a system.

The boilers used for low-pressure steam heating are mostly made of a cast iron of sectional form,—*i. e.*, a number of separate sections are bolted or screwed together to make a complete unit. These sec-

tions are made in two general types, — those that stand upright, with each section resting on the foundation, or base, and those that are horizontal in form, and set one on top of another. In Fig. 1 is shown the outline of the vertical type, giving a good idea of its shape and the method of connecting the sections. This form of boiler has many advantages over the horizontal type. It can be enlarged by adding additional sections. The grate area is enlarged as the sections are added. The joints connecting the sections are exposed to view, and the boiler can

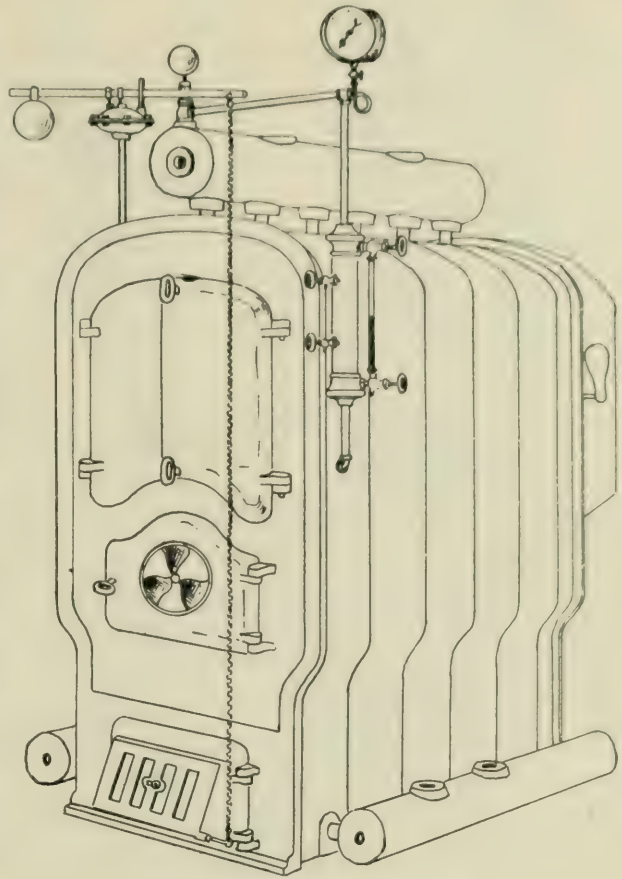


FIG. 1. VERTICAL BOILER.

always be put together without the aid of packed joints. The vertical form is also better for steaming, inasmuch as the circulation is much quicker, and the steam can more quickly escape to the surface. Fig. 2 illustrates a boiler of the horizontal type, with the sections placed one above the other. Many of these give good results, but they do not admit of as strong construction as does the other type; they cannot be as easily enlarged, or as easily cleaned; and they are nearly always made with packed joints, which are liable to give out and need repairs. A very large number of boilers of this type have been sold, because of the magazine attachment, or self-feeder, with which so many of them are supplied. To a house-owner, this feature often appeals very strongly, but it is really of little advantage, as a surface-burning boiler will hold steam for ten hours, and more than that is not necessary. A magazine attachment is a detriment to the heating qualities of a boiler, as it takes up space that would be valuable as heating surface, and prevents the proper combustion of the fuel. Steel and wrought-iron boilers, of various forms, are also used for low-pressure heating. Those most in use are the tubular form,

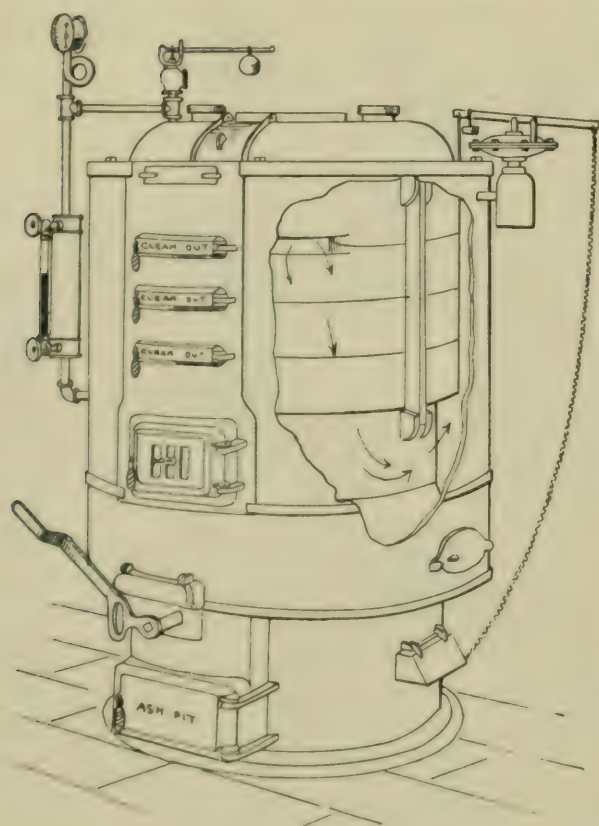


FIG. 2. HORIZONTAL BOILER.

both vertical and horizontal. For very large plants the tubular boiler has some advantages over the cast-iron sectional boiler. The large steam space makes the apparatus work more uniformly, and in large sizes they will work with greater economy, as the brick-work setting enables the heat to be carried into contact with all parts of the surface of the boiler, which cannot very well be done with a cast-iron type. This, however, does not apply to a boiler of less than forty horse power. The factor of safety is rather in favor

of the cast-iron boiler, but the danger from explosion in a low-pressure boiler is so small that it hardly need be considered.

The fixtures used with a low-pressure boiler are shown in Figs. 1 and 2, and consist of a safety valve set to blow off at ten pounds, a steam gauge, a water gauge and column, draft regulator, blow-off cock, and sometimes an automatic water-feeder. The latter, however, is of doubtful advantage, as the quantity of water used in such an apparatus is very small. Wrought-iron and steel boilers are nearly always set up in brick work, while cast-iron boilers are generally protected only with a coating of asbestos cement or a galvanized iron casing.

There are two general systems of piping used in gravity steam heating, one being known as the two-pipe system, illustrated in Fig. 3. It has a complete system of feed pipes, and a corresponding run of return pipes, each radiator having two valves. The other is known as the single pipe system, shown in Fig. 4. The single-pipe system may be put up in different ways. That shown in Fig. 4 is called the single-pipe circuit system, and is probably the best method to adopt for single-pipe work. In this application of the single-pipe system the water of condensation is carried in the direction in which the steam is flowing,

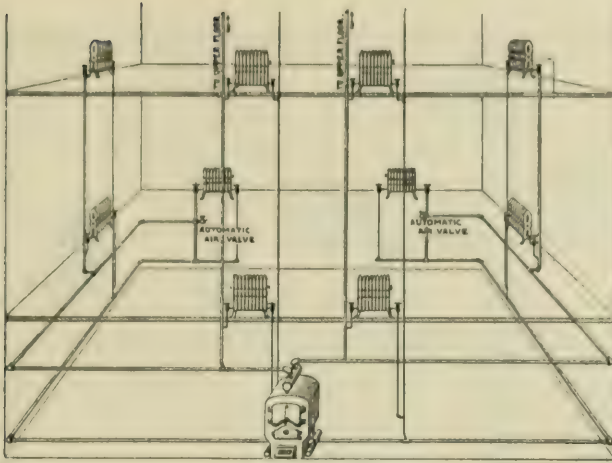


FIG. 3. DOUBLE-PIPE SYSTEM.

except in the case of the rising pipes, and is returned to the boiler with very little loss of heat. Fig. 5 shows another application of the single-pipe method, in which all distributing horizontal pipes drip towards the bottom of the rising pipes, where relief pipes are attached to carry the water of condensation back to the boiler. Fig.

6 represents still another form of single-pipe work, and it is considered by many engineers the best form for large plants. In it the main feed pipe is run to the upper part of the building, and the various branch pipes are carried to points where lines of radiators are to be placed. From here runs of pipe are dropped to feed the various radiators on the floors below. At the bottom of each line in the cellar a system of return pipes is connected to collect and return the water of condensation to the boiler. The steam in this system goes through the entire apparatus in the direction in which the water flows and on that account it has its advantages. The installation of any of these systems is attended with good results, if the work is properly done and the proper sizes of pipe are used for the required work, while any application will be a partial or complete failure, if care is not used.

The proper size of steam pipe for a given amount of radiation has been the subject of a good deal of attention among engineers, and a good many rules have been devised to give the needed size. An investigation of the rules given in the text-books now published shows a wide variation in the conclusions, the rules submitted by four writers varying as much as one hundred and thirty per cent.

For some years I have thought that some

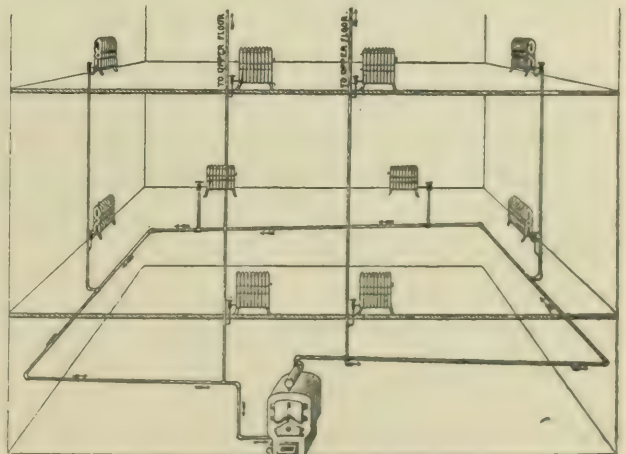


FIG. 4. SINGLE-PIPE CIRCUIT.

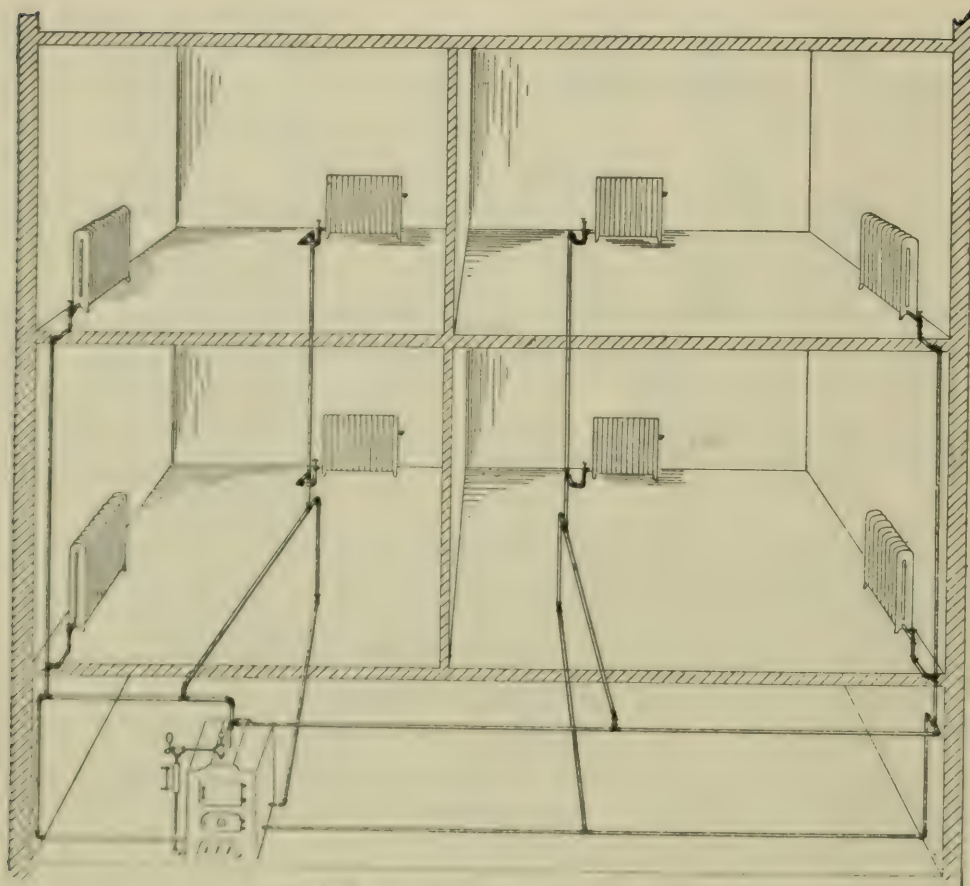


FIG. 5. SINGLE-PIPE DRIP RISERS.

simple rule could be devised that would give a proper ratio for all sizes of plant, and, with this end in view, I have made various observations from time to time to verify the correctness of the rule herewith submitted. It seems to accord very closely with the practice of many successful engineers. Almost all the rules heretofore given seem to have been the same for all sizes of plant. This is a mistake, as I find from close study that a different ratio is required for each size. A ratio satisfactory for a plant of 2,500 feet of radiation is not satisfactory for one of 800 feet.

To determine what is necessary to supply one hundred feet of radiation through one hundred feet of feed-pipe, we will consider the following points. One foot of radiation will lose about 255 units of heat per hour when exposed in a room at 70° . This makes a total of 25,500 units for 100 feet. As there are 966 units of heat in one pound of steam, at atmospheric pressure, we have to supply 26.4 pounds of steam per hour. Now, as there are 26.37 cubic feet of steam to a pound, we have to supply 696 cubic feet of steam. If we did not have to allow anything for friction, we could pass 766 feet of steam per hour through a $1\frac{1}{4}$ -inch pipe at a velocity of 25 feet per second ;

but the losses by friction and condensation are so great under these conditions that we have to allow fully seventy per cent. to insure satisfactory results. Having satisfied myself of what was necessary to get good results in the case of 100 feet, I determined to adopt some constant to determine the ratio per one hundred feet of surface that would be accurate for any size of pipe. A further investigation led me to

adopt the following simple rule to determine this ratio: $r = \frac{3.141}{d}$,

in which d is the diameter of the main steam pipe, and r the ratio needed in square inches for each one hundred feet of radiation in the system. To determine how much each size of pipe will carry we

have this expression: $R = \frac{a}{r} \times 100$, in which a is the area of pipe, r the ratio as found in the former expression, and R the total amount of radiation the pipe will supply. From this we get the following table:

Size of pipe.	Ratio per 100 feet of radiation.	Area of pipe.	Amount of radiation each size will supply.	Size of pipe.	Ratio per 100 feet of radiation.	Area of pipe.	Amount of radiation each size will supply.
1½	2.10	1.767	84	6	.52	28.274	5440
2	1.57	3.141	200	7	.45	38.484	8550
2½	1.25	4.908	400	8	.40	50.265	12566
3	1.04	7.068	700	9	.35	63.617	18100
3½	.90	9.621	1062	10	.31	78.54	25300
4	.78	12.566	1590	11	.285	95.03	33200
4½	.70	15.904	2272	12	.26	113.09	43000
5	.63	19.635	3120				

The areas of commercial sizes of pipe are a little different from the circular areas given in the table. This does not affect the rule, but will change slightly the radiating surface corresponding to a size as given in the table.

For each one hundred feet that the main pipe is extended beyond the first hundred the ratio of the pipe next smaller should be used.

All horizontal steam pipes should have a regular fall in the direction in which the steam is flowing, a good fall being one inch in every ten feet. This will remove quickly all water of condensation, and prevent the cracking noises one so frequently hears in steam pipes.

It used to be considered necessary to have a distinct flow and return pipe to each radiator, in order to secure good results, and a good many engineers still cling to this idea, but it is a mistake. Water will return freely down a rising pipe, while steam is flowing up. The water of condensation clings to the inner surfaces of the pipe, and drips down, in much the manner that moisture runs down the sides of a water-cooler filled with cold water in warm weather. A larger pipe is needed for single-pipe work than for double, but, if of proper size, one pipe will do the work with greater efficiency than two.

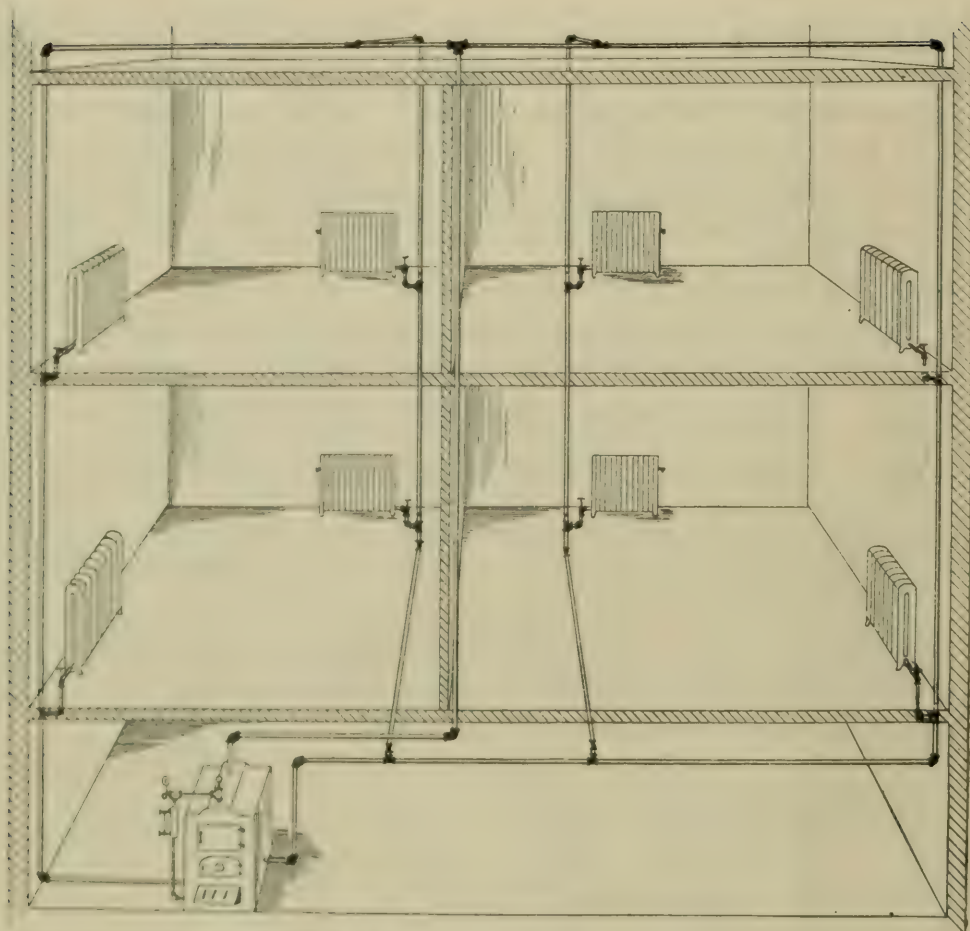


FIG. 6. SINGLE-PIPE TOP FEED.

The radiators used in steam heating, though of numerous patterns, may be classed under three distinct heads. The direct radiator, is made in a number of designs, and is intended to be set directly in the room to be heated. The semi direct radiator, as shown in Fig. 7, is used to heat the room, and to supply a current of fresh air from the outside through the radiator into the room. Radiators of this class are supplied with regulating dampers to control the quantity of air admitted through them to the room. The indirect radiator, shown in Fig. 8, is always placed in a chamber in the basement beneath the room it is intended to heat. The chamber may be made of wood and be lined with tin, or it may be made entirely of galvanized iron or brick work. Air is brought from the outside to the lower portion of the chamber; it is then passed through the sections of the radiator to the upper part of the chamber, whence it is directed through pipes, or flues, to the room to be heated.

When the semi-direct or indirect radiators are used, some means of exhausting the foul air from the rooms must be provided, especially

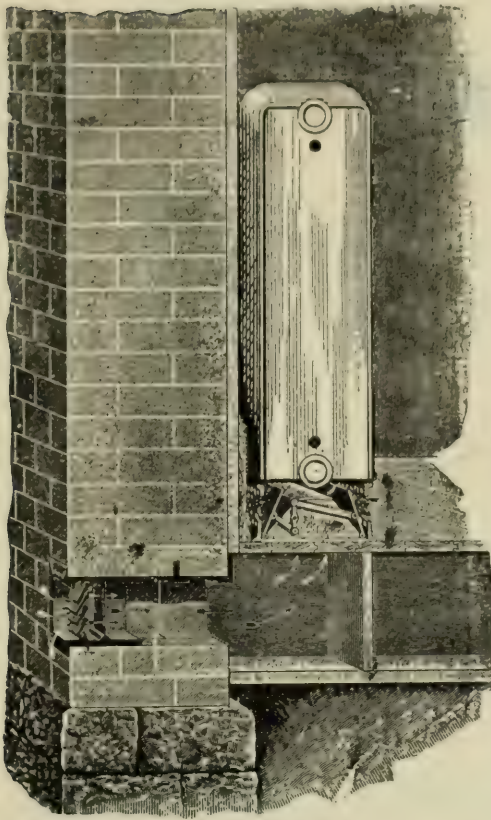


FIG. 7. SEMI-DIRECT RADIATOR SYSTEM.

inlets are of advantage, it is found that one outlet gives better results than a larger number.

The indirect method of heating is generally resorted to for the purpose of keeping the radiator out of the room, either because there is no room for it, or because its appearance is objectionable, but it is also resorted to for purposes of ventilation only. In residence work it is nearly always put in as shown in Fig. 8, but, when used for ventilating purposes mainly, it is put in as shown in Fig. 10 in which the arrangement of an indirect radiator system is given in connection with a special ventilating flue. For

in the case of the indirect; as the heating of the room depends entirely on the circulation of the air through the radiator. In ordinary residences the fireplace chimney will be sufficient for this purpose, but in larger buildings special flues should be provided. The semi-direct radiator is very much used for schools and hospitals, or similar buildings where large quantities of fresh air are needed for ventilation. This system has the advantage of being able to supply fresh air at as many points in the rooms as there are radiators. Figure 9 shows a room containing six semi-indirect radiators, while the air exhausted at one foul-air register. The supply of fresh air at six different points makes it almost certain that the air in the room will be constantly changed, without creating drafts at any point. While a number of

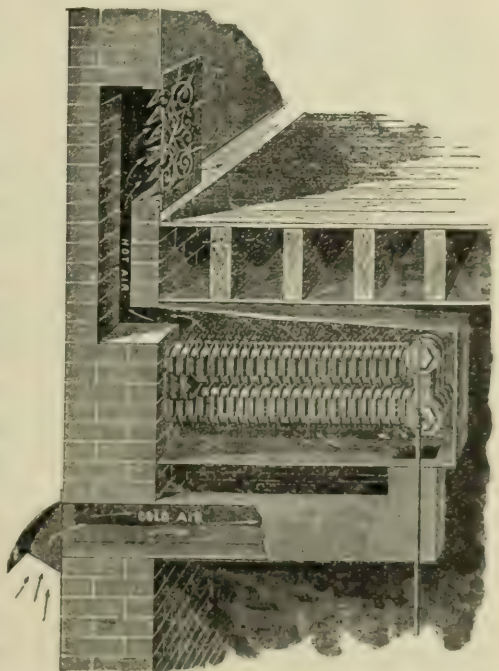


FIG. 8. INDIRECT RADIATOR SYSTEM.

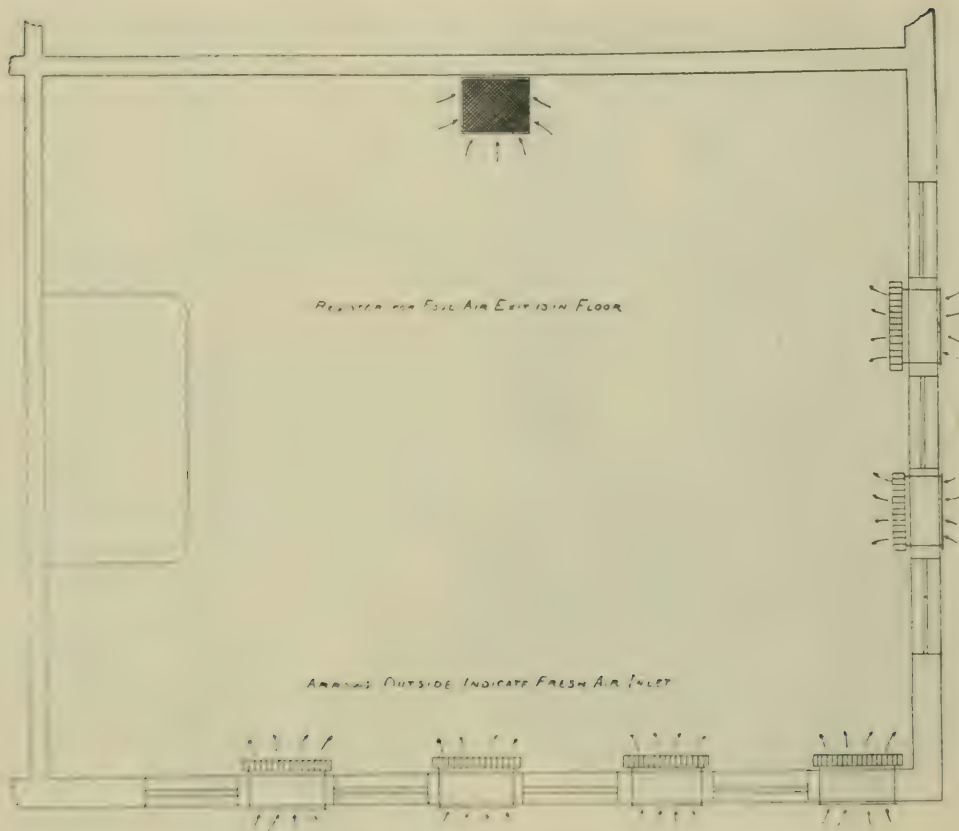


FIG. 9. ROOM WITH SEMI-DIRECT RADIATION.

such uses radiators are made with sections at greater intervals to admit of a rapid circulation of air through them. The chamber used for this work is much larger, and is supplied with a mixing damper, so that the air can be tempered without the quantity being diminished. In all cases where this method is adopted it is well to place the register in the wall, on the inside of the room, about eight or nine feet from the floor, and the air should be projected towards the cold side of the room, as shown in Fig. 10. The foul air should be taken out at the floor on the side of the room where the air is brought in. The circulation will then be about as indicated by the darts in Fig. 10. With this method of ventilation, and with the gravity system of steam heating, it is common to get a change of air in large rooms from six to ten times per hour.

A very important matter in steam heating is the removal of the air from the radiators, as the steam rises up to supply them with heat. To effect this purpose air valves are used, and, though an ordinary air cock will answer for the purpose, the valves generally used work automatically,—*i. e.*, they open when cold, and close by expansion when heated. Various patterns of these articles are sold, but they

may be classed under two heads,—one kind closing by expansion only, either by a composition plug or metal strips, and the other, the float valves, closing by expansion when heated, but, when the radiator gets full of water, closing by the action of the float. By the use of automatic valves of a good pattern, the air leaves the radiator as the apparatus heats up, and again enters it when the steam cools down. It is just as important that air should be let in when the radiator cools, as it is to let it out when it heats up, for the reason that, if the radiator cools and no air is let in, a vacuum is formed, and the water is liable to be lifted out of the boiler.

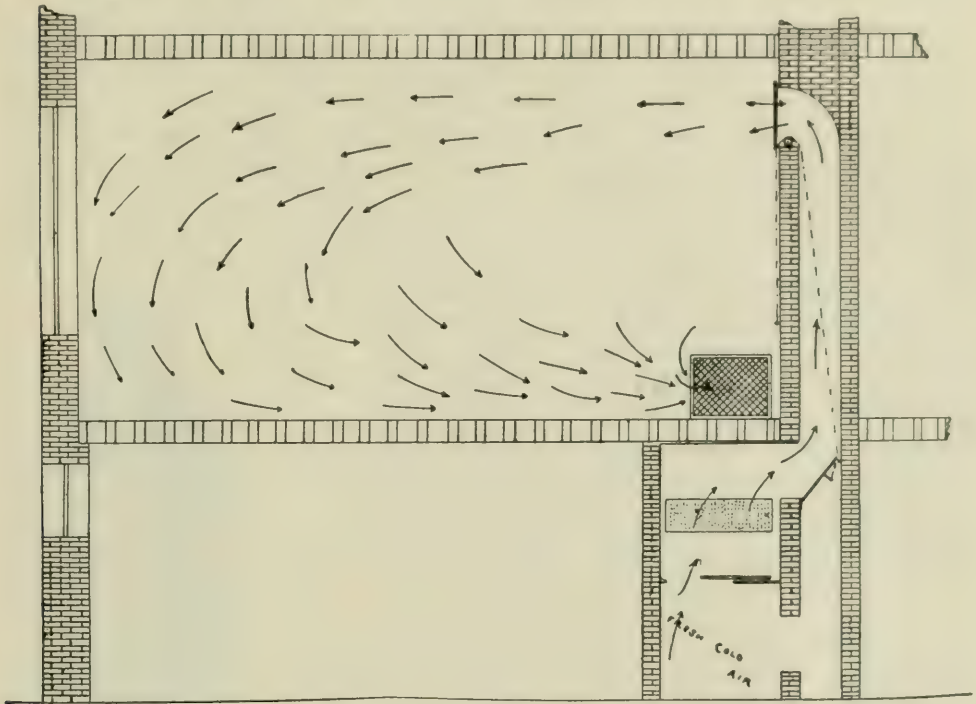


FIG. 10. ROOM WITH INDIRECT RADIATION.

Economy in the operation of a steam plant is effected very largely by the working of the air-valves. This is very marked in a large plant,—so marked that in some cases I have examined, when mechanical means had been resorted to for removing the air from the radiators, a saving of 25 per cent. in fuel resulted. Fig. 11 illustrates one type of plug-expansion valve, and Fig. 12 one of the float type.

A building loses heat through the windows, or glass surface, through the exposed walls, and by the changes of air in the rooms. One rule very widely used is based on the cubical contents, with an arbitrary allowance for more exposed rooms. It is as follows: One foot of radiation will heat 60 cubic feet of space in inside rooms with one exposure and the average windows; 50 cubic feet in rooms with two exposures and average windows; 40 in a room with three sides exposed

and windows on each side; and 40 in bath-rooms,—all for rooms in residences on the ground floor. For the second floor 10 per cent. less is needed, and for the third floor 20 per cent. less, the quantities for these floors being governed by the fact that the heat rises from the

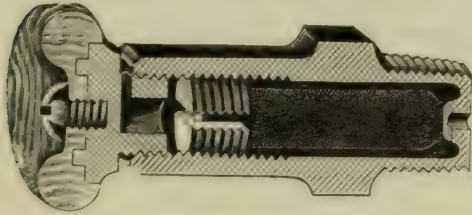


FIG. 11. PLUG EXPANSION AIR VALVE.

lower floors through the halls. If, however, these floors are not open, one to the other, they are treated as ground floors. For stores and such buildings it is usual to figure one foot of radiation to 60 or 70 cubic feet of space; and, with exposures only at the

front and back, as in the case of stores in the middle of a block, one to 80 or 100 is sufficient. Another and more refined rule for ascertaining the required amount of surface is advocated by Prof. R. C. Carpenter, of Cornell University. "One quarter of the exposed wall surface in square feet, the square feet of glass exposure, and $\frac{1}{5}$ of the cubical contents,—this, divided by four, gives the amount of surface in square feet needed for the room." This involves a presumption that the air in the room is changed only once an hour, but, as a matter of fact, two or three changes per hour must be provided for. It is customary to allow, in halls in houses, for three changes, or $\frac{3}{5}$ of the cubical contents; for rooms on ground floor, $\frac{2}{5}$; and for rooms on the second, $\frac{1}{5}$. This rule seems to work very satisfactory, if applied with judgment. It must not be understood that it is arbitrary for all exposures, for it is customary to add 10 per cent. in the case of northerly or very exposed rooms, and to deduct in the case of those that are less exposed. If semi-direct radiation is used, it is customary to add 25 per cent. to the amount needed for direct, and, if indirect is used, 50 per cent. is added the proper number of air changes being provided.

The cost of erecting steam heating for residences by direct radiation averages from $1\frac{1}{2}$ to $2\frac{1}{2}$ cents per cubic foot of space heated, and for indirect from $2\frac{1}{2}$ to 4 cents per foot of space heated. For schools heated and ventilated by the methods illustrated in Figs. 9 and 10 the cost is about \$250 per room of the average size, seating fifty pupils, and in which the air is changed eight to ten times per hour.



FIG. 12. FLOAT AIR VALVE.

MINING THE GOLD ORES OF THE WIT-WATERSRAND.

By H. H. Webb and Pope Yeatman.

IT is hardly possible, in a magazine article, to write in more than a cursory way on a subject so extended as "Mining on the Witwatersrand," the Rand being many times greater in area than any other gold-mining camp of the world. It is a field on which have been centered mining engineers of several nationalities, the largest percentage of whom are English and American, all "digging out" the same problems under the same conditions,—with few local variations,—bringing to their aid different methods of thought and training, yet all confined within one broad channel of operation and a more or less established method of procedure.

The Witwatersrand proper may be said to extend from Boksburg on the east to beyond Krugersdorp on the west with the city of Johannesburg as a center—a distance of some forty miles. If the off-shoots, Heidelberg on the east and Klerksdorp on the west, be added, the total length of the mining reefs will approximate one hundred miles. For the greater part of the central section, one may drive mile after mile along what might be called an avenue of the largest gold-mining properties in the world, comprising both outcrop and deep-level companies.

A more tangible conception of the magnitude of the industry may be gathered from a consideration of the following table, giving the gold output, according to the State mining engineer's returns, for the years 1895 and 1896, and up to the end of September, 1897. It will be noticed that the output has been progressive, that of 1896 being a little higher than that of 1895, while that of 1897, taking into account the approaching advent of several additional companies as producers, should reach, or even exceed, 3,000,000 ounces.

GOLD OUTPUT.

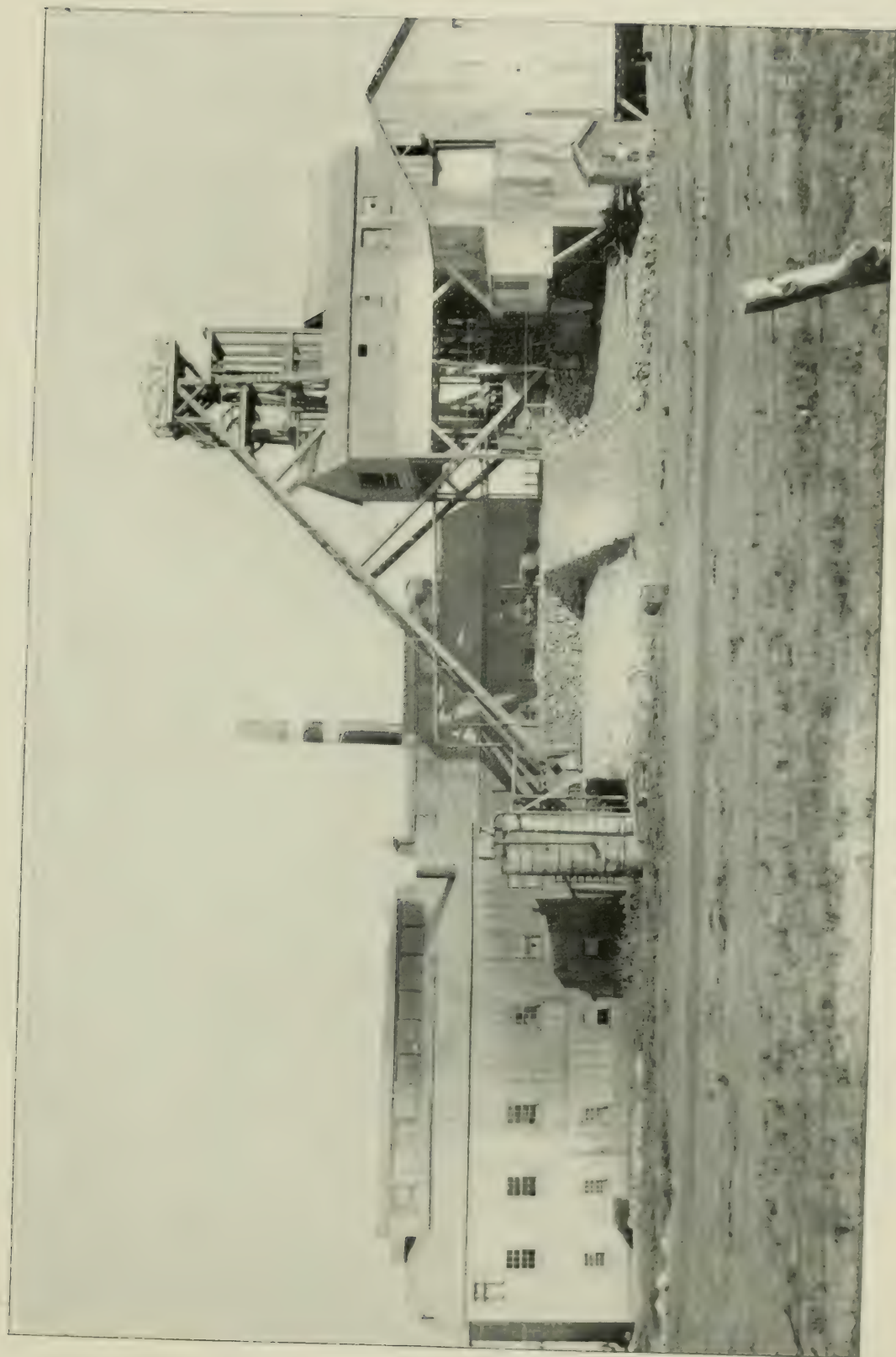
Year.	Tonnage Tons of 2,000 lbs.	Total yield.		Total value.	Av. yield per ton bullion.
		oz.	dwts.		
1895.	3,456,575	2,277,640	-4	£7,840,779	13.2 dwts.
1896.	4,011,707	2,280,892	-4	£7,865,341	11.3 "
To Sep. 1897.	3,789,776	2,152,664	-0	£7,496,479	11.3 "

The first row of deep levels, which are gradually swinging into line as producers, and which have tapped the reefs at depths varying from 500 to 1,500 feet, will ere long have to transfer their name of "Deep" to the second row, whose depths will vary from 1,800 to 3,000 feet, and on some of which sinking is in active progress at present. Deep workings will undoubtedly extend to the third row, with depths of shafts from 4,000 to 6,000 feet, and probably beyond that. The factors to be considered—heat, water, and mechanical appliances—will not prove insurmountable difficulties. At the Robinson Deep, where the No. 1, or eastern, shaft has reached a depth of 2,450 feet, the difference in temperature between the surface and the lowest workings is 11 degrees, or a rise of 1° F. every 200 feet,—this, too, in a shaft which at present has no underground connection with its brother shaft, No. 2, or with the surface. Such a variation can hardly be considered as denoting a ratio prohibitive of working at double the depth. The degree of variation was ascertained by sealing a recording thermometer in drill holes, and allowing it to remain for a considerable time; the figures have been verified by similar experiments in other deep shafts. Where there is artificial ventilation, the temperature in the working places may be expected to be lower.

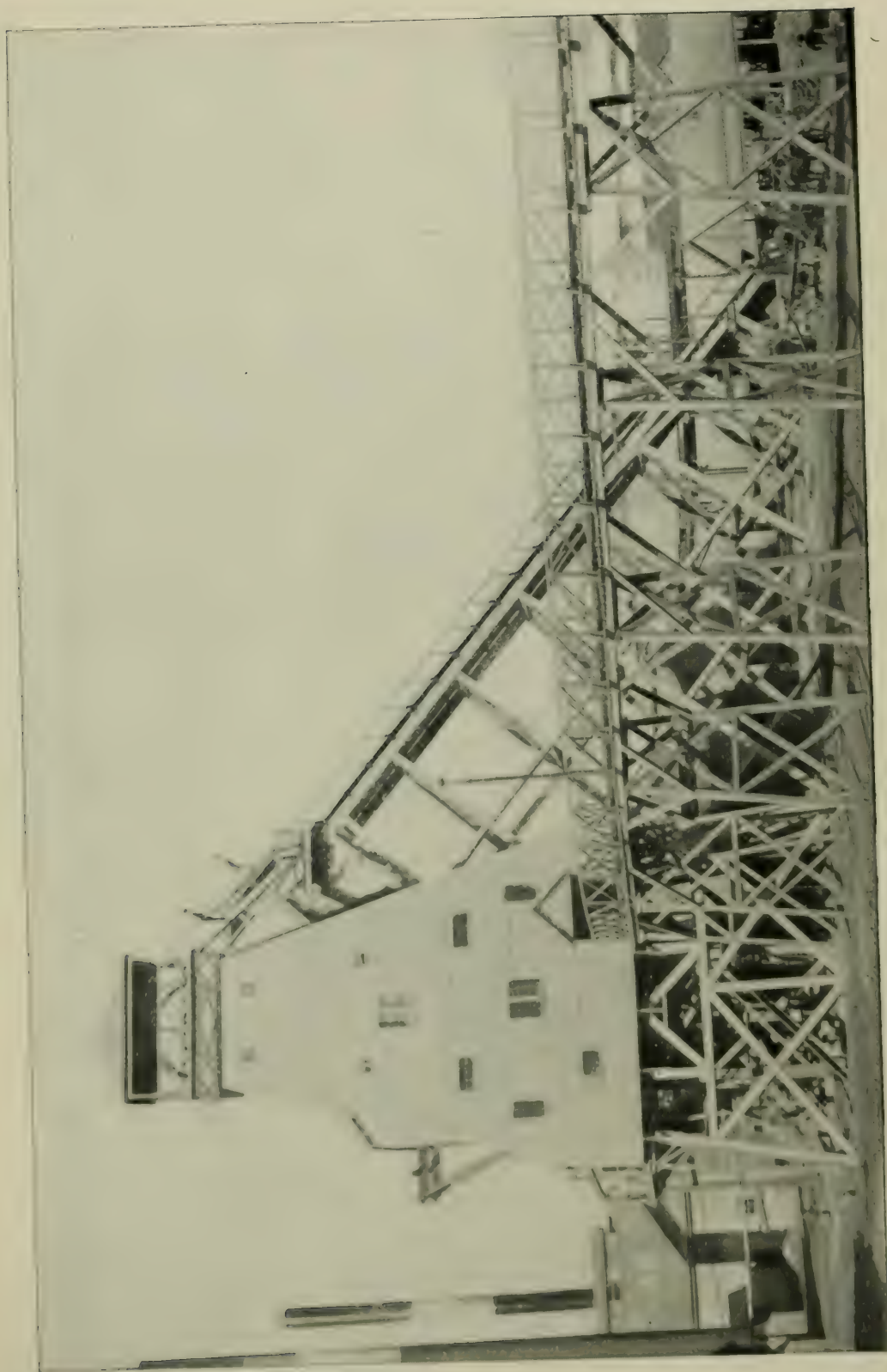
In the matter of water, the Witwatersrand may be considered fortunate. Again citing the Robinson Deep, the deepest mine at present on the Rand, the use of pumps, except near the surface, has so far been found unnecessary, the slight amount of water encountered being handled easily by bailing in the ordinary course of hoisting the regular loads with skips. In the two shafts the water does not exceed fifty gallons per minute, three-fifths of which is taken up at a depth not greater than two hundred and fifty feet. This may be local, but the general experience on the Rand tends to show that the greatest amount of water is found at depths comparatively near the surface. There are exceptions to this, and cases may be cited where water has proved troublesome, but even these, in the small amount of water they have had to handle, will compare most favourably with many other mining districts.

In the matter of mechanical appliances, the Rand, with the rest of the world, is progressing. The cosmopolitan character of its mining inhabitants stimulates to an energy and rivalry unusual in other mining centers. In hoisting, the Rand can do what has been done elsewhere,—as at the copper mines of Lake Superior, where shafts have already been sunk to depths of about 5,000 feet.

One might subdivide the mines of the Witwatersrand into out-crop and deep levels, but this distinction, while strongly marked at



VERTICAL SHAFT, LANGLAAGTE ROYAL GOLD-MINING COMPANY.



HEADGEAR OF INCLINE SHAFT, KNIGHTS GOLD-MINING COMPANY, WITWATERSRAND.

present, will, in a few years, become nominal. The outcrops have passed through the initiatory stages of prospect work and cheap equipment,—of feeling their way, as it were,—and now, in consequence of the work done by them and the first row of deeps, confidence may be said to have been established for future depths.

Equipment. The modern equipment of an outcrop property may be said to differ but slightly, and only in detail, from that of a deep level. The old and substantial “stand-by,” the Cornish pump, holds its own for moderate depths of, say, 1,000 to 1,200 feet, and is characteristic in the outcrop equipment, the average size being about 8 inches with a stroke of 5 or 6 feet and lifting from 250 to 375 feet. For the deeps, the electric, or some other, air pump will take its place. At the Knights Deep three-throw electric pumps of the three-phase system have been installed in the shafts, with lifts of 500 feet. The Rand Mines, Limited, are prepared to use Reidler differential air pumps, with 1,200 feet lift. With the deeps the head gear and winding engines are necessarily heavier. Underground the workings are much the same,—development, haulage, and stoping differing not at all, or but slightly. A description of one will serve for the whole, save in a few details, and the problems to be solved are as much those of economic management as of mining and engineering skill.

Shaft-sinking, with few exceptions, has been done by native hand labour, the rate of progress in a well-started shaft being from 60 to 164 feet per month, 156 feet being done in the west shaft of the Simmer & Jack East for the month of July and 164 feet in the west shaft of the Angelo Deep for the month of August, the former in quartzite and the latter in slate. This rapid rate of sinking could not have been much exceeded by machine drills, for the time lost in sinking is spent in removing the dirt from each succeeding blast, which must be done by hand labour and occupies at least one-half or five-eighths of the whole time. For this work the highest wages paid to natives is 2s. 6d. per shift; whites receive about £1 per shift, with the incentive of a bonus per foot for sinking in excess of a certain amount per month. The average rate of sinking for the first nine months of 1897, in two deep shafts in which rapid work has been done, was a trifle over 100 feet per month, and the cost per foot, including white labour, native labour, compound expenses, timber, explosives, lubricants, miscellaneous stores, fuel, maintenance, and engineering fees, was £21 19s. 7d.

The cost of sinking inclined shafts has been less, for the reason that, when the necessary points were reached, levels were started and driven, and the burden of the general operating expenses was thus

distributed, not only over shaft-sinking, but over drifting and general development as well, whereas in the case of vertical shafts no distribution of expenses could be made until the reefs were reached.

The shafts on the outcrops have generally been of three compartments,—two for hoisting and one for pumping and ladder way. On the first row of deeps the shafts have usually four compartments,—one for pumping, one for men, and two for hoisting; on the second row of deeps the tendency is to five compartments.

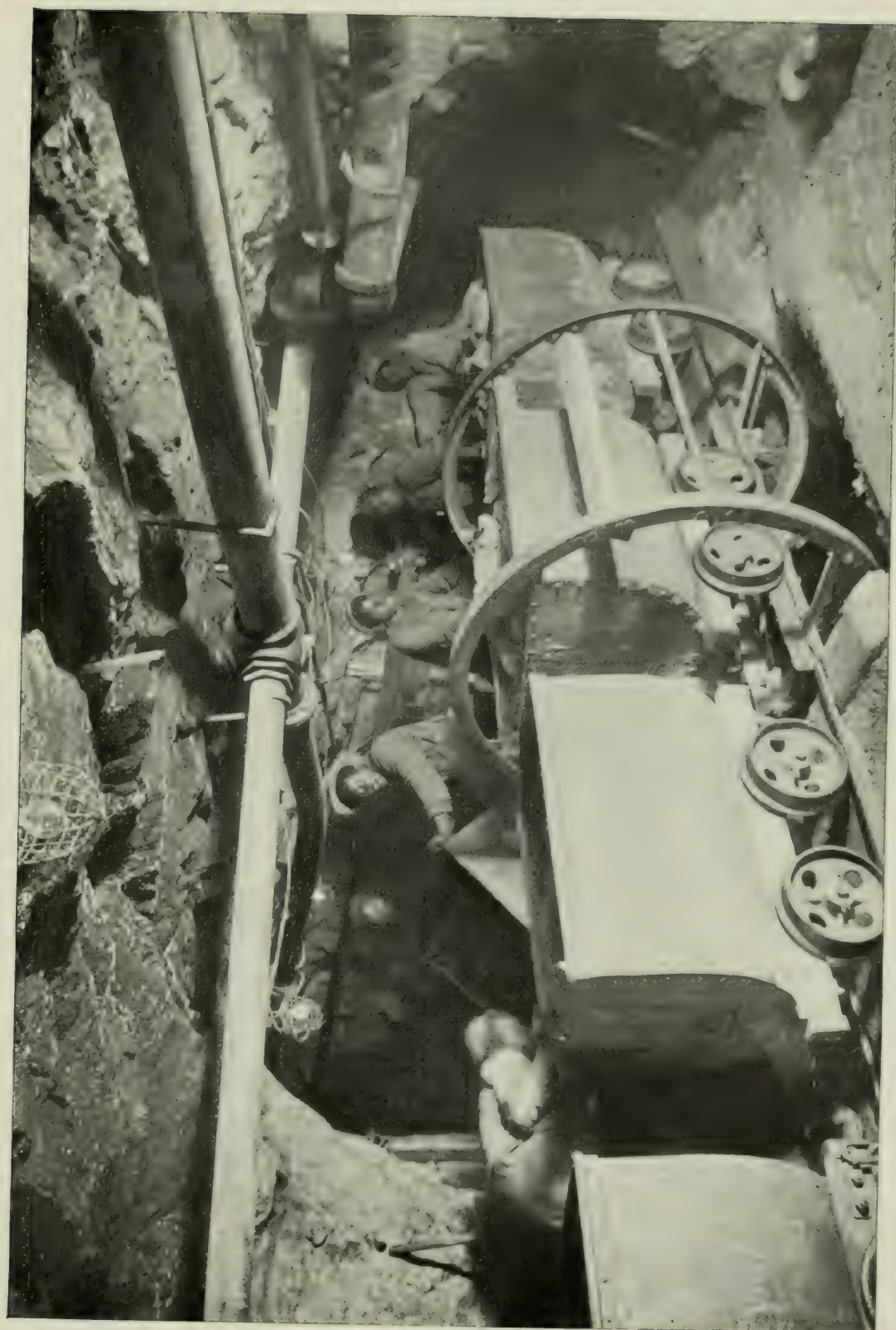
In a few vertical shafts cages are used, but self-dumping skips of from 1 to 3½ tons' capacity are the rule, and during sinking operations, in many of the shafts, buckets are employed, better progress, as a rule, being made in sinking with them, as the timbering can be kept sufficiently far above the bottom of the shafts to prevent injury when blasting, and the time lost in removing the blast can be lessened by the continuous loading possible where there is always a bucket at the bottom. While flat ropes are used in some cases, the round rope is the most common. Of course, on incline shafts the flat rope is impracticable.

In the first row of deeps it is the practice, on cutting the reefs, to turn off on the underlay, and continue the shaft-sinking on the incline. In very deep shafts an electric or air hoist will probably be placed in the station at the head of the incline, and all ore below that point hoisted to the station in skips and dumped into pockets, or bins, leading into the vertical shafts, from which skips will be loaded and hoisted direct to the surface.

Electric hoists of 300 k. w. are being installed in the main stations of the two shafts of the Robinson Deep, and will be used for working all the property below that point, receiving the loads at the various stations on the incline and hoisting to the bins at the main station, from which skips in the vertical shafts will deliver the ore to the surface. From the inclines levels are driven at distances varying between 100 and 200 feet, depending on the dip of the reefs, and the rapidity with which it is desired to open up ground for milling. At each of these levels it is customary to put in pockets connecting with the incline.

Shaft Timbering. There being no native timber of suitable quality, Oregon pine is generally used. At one time Australian Karri wood was introduced, but, owing to its high first cost, expense of framing, and weight, it has been abandoned. It is probably a very durable wood, and was used in order to lessen the cost of shaft repairs, which in a highway of great traffic is an item to be considered.

The shaft timbers consist of the usual wall plates, end plates, dividers, and studdles, well wedged, with bearers every 50 to 100 feet



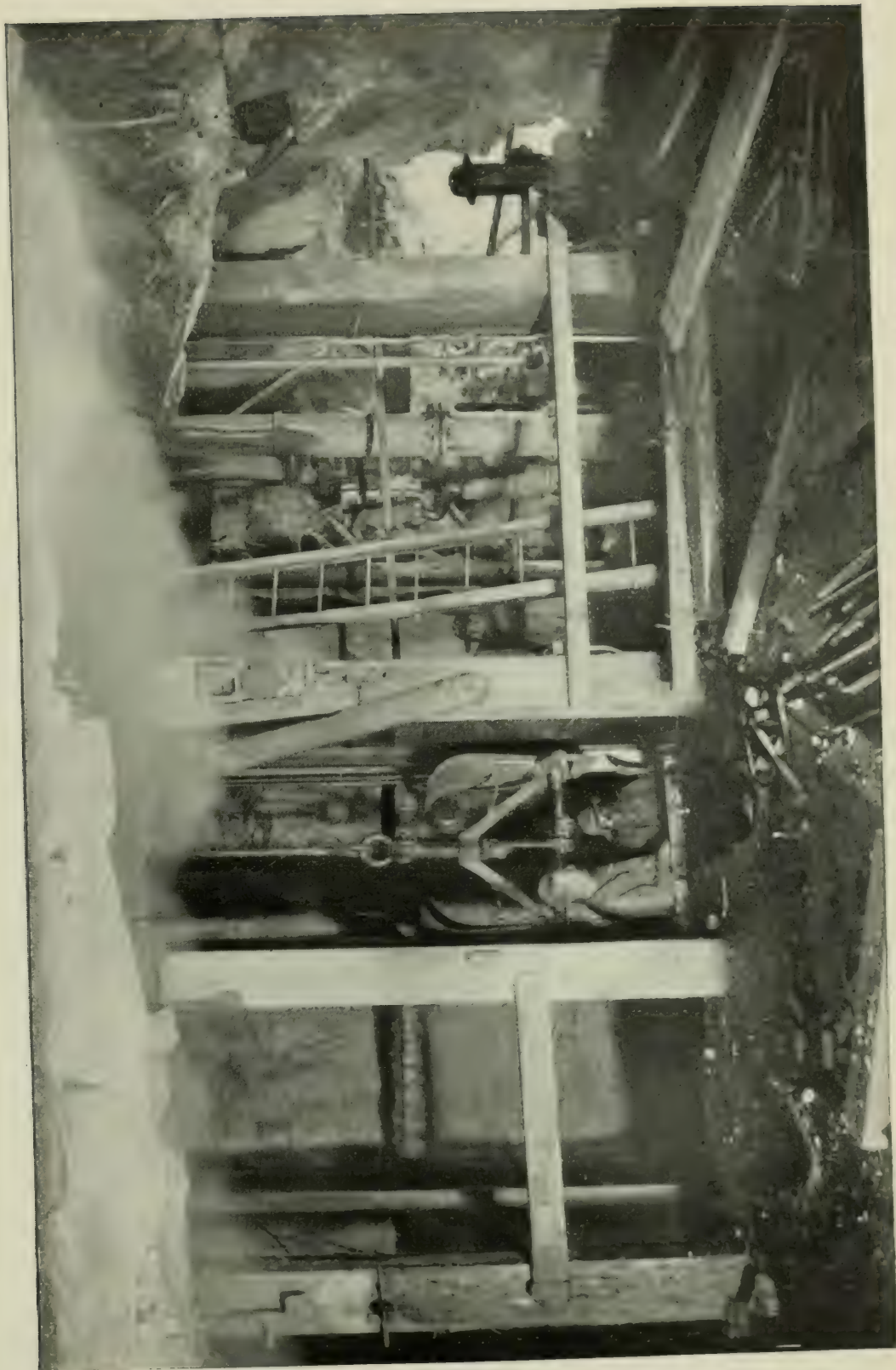
TIPPLERS AT NORTH VERTICAL SHAFT, SIMMER & JACK PROPRIETARY MINES, WITWATERSRAND.

resting in hitches cut in the rock. For Oregon pine the wall and end plates are 8×8 or 8×10 , studdles 8×6 or 8×8 , dividers 6×8 , end bearers 10×12 , intermediate bearers 6×12 , and guides 5×4 .

The cost of timbering a five-compartment shaft averages from £3 5s. to £3 10s. per foot. Lagging is but little used, save near the surface, or at occasional spots where loose ground is encountered; it generally consists of 3×9 deals.

Development. In opening up a mine the following plan is usually pursued. Drives are driven on the reef, east and west. In some cases, where payable reefs are close together, one main drive is sufficient, but in most instances it is necessary to crosscut to the second reef, and run another main drive along that. From the main drive, at distances of between 200 and 400 feet or more, upraises are driven to connect with the level above, and winzes sunk to the level below. At distances of about 40 feet boxholes for receiving ore from the stopes are put in.

The work of development is generally done with machine drills. Were it a question of individual ownership of the several mines, and were time no object, native hand labour would undoubtedly be cheaper, but in opening up a property, say, a deep for 120 to 200 stamps, or in keeping a large outcrop mill running and development well ahead, with perhaps an impatient body of shareholders in England or elsewhere, time is of importance, and the air drill serves the purpose in a superior degree, besides supplying ventilation. In a new property, interest on the money to be invested is to be considered, and quick time in reaching the producing stage is of great importance. In an old property—a steady producer, with a fair amount of development ahead—hand labour can be used to advantage. The drills most in use are the Ingersoll-Sergeant and the Rand-Slugger. The rates of progress vary. In single drives, where one machine is used, from 60 to 100 feet are driven per month; in double drives, where two drills are operating, from 90 to 120 feet. The work is generally let by contract at from £2 to £2 10s. per foot for single drives and £3 to £3 10s. per foot for double drives, the contractor supplying labour, candles, and explosives, and the company supplying drills, air, maintenance, etc. Lower rates prevail when the contractor is provided with at least two faces to work, for then no time in drilling is lost while the dirt from each blast is being removed. With native labour the rate of progress would be from 30 to 50 feet per month, and the cost per foot from one-half to two-thirds that of machine work, with no air or maintenance to be supplied, but with ventilation poor. Timbering has seldom been necessary in the driving of levels, or, in fact, in any of the underground work.



STATION AT HEAD OF INCLINE, NO. 1 SHAFT, SIMMER & JACK PROPRIETARY MINES.

Tramming the ore from the faces or from the boxholes is usually done by boys. The trucks employed have a capacity of about 16 cubic feet. The gauge is 18 inches, and the weight of the rails varies from 12 to 16 pounds per yard. Tramming and loading in drives, when done by contract, costs from 5d. to 6d. per load of 1,800 pounds.

Stoping. Stoping is done both by hand labour and by machines. So far hand labour has been much the cheaper, and machines have been resorted to only when native labour was scarce. By the employment of smaller machine drills, and allowing one white man, with the aid of natives, to run two or more drills, it is possible to make the cost of hand and machine labour approach each other. The employment of small drills will reduce the excessive amount of dynamite used per ton of rock broken, the cost of labour by the substitution in part of native labour for white, and probably the cost of power, steel, etc. Another great advantage which will result from this modification will be the reduction of the number of natives required,—an important consideration in view of the scarcity of natives at certain seasons.

The smaller drills, compared with the larger ones, are easier to handle, require less air to operate, drill smaller holes, and can be used in narrower stopes. With the large drills a stope of from 5 to 6 feet is necessary, while with a small drill one of 36 to 40 inches can be mined. On narrow reefs a small stope should be mined, as otherwise too much barren ground, of which only a small percentage can be sorted, will be broken down, and so the grade of the ore will be reduced.

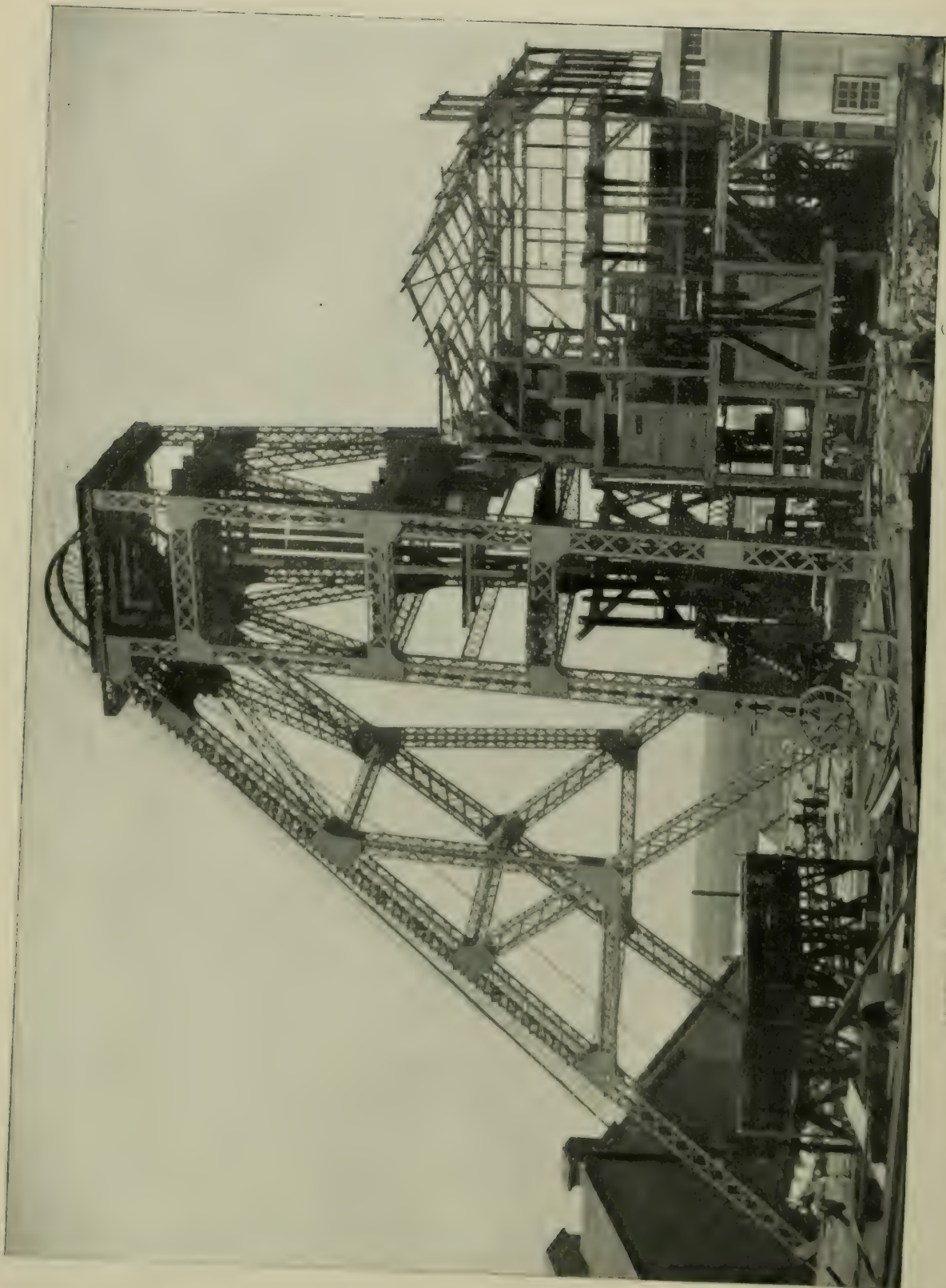
Where stoping is done by hand, underhand stoping is the rule, as Kaffirs, not being skilled miners, do much better work in underhand than in back stoping. In opening up a stope by hand, the work is started on both sides at the top of an upraise, and gradually widened and carried on to the bottom. Where machines are used, underhand stoping, back stoping, or breast stoping may be employed.

In developing quickly, the method of back stoping is often used, a back drive being driven on the reef above the main drive, leaving a pillar of 8 to 10 feet between, and on the former the stopes are started. The rock is blasted towards the boxholes, so as to diminish shovelling as much as possible. The pillars can afterwards be robbed. Drives are either protected by leaving a strip of the reef, as before indicated, or by putting in stulls and lagging.

Including shovelling, the average cost of stoping 12,000 tons for the month of September at the Simmer & Jack Proprietary Mines, Limited, was 6.8 shillings per ton milled, including all supplies,



STOPE, 4TH LEVEL EAST, EAST INCLINE SHAFT, SIMMER & JACK PROPRIETARY MINES.



SORTING AND CRUSHING STATION, NO. 2 SHAFT, ROBINSON DEEP MINING COMPANY.

labour, office expenses, management, insurance, etc. The cost of shovelling was about 1 s. per ton milled.

When the reef has a dip of 40° or more, the expense of shovelling is not so great, but below 30° the cost becomes considerable. When the reefs are flat, it is possible to run trucks into the stopes, and load them there.

For holding up the roof, stulls are sometimes put in, or pillars left. Very few supports are required, the backs being strong. In carrying on stoping with Kaffirs, one white miner has charge of one or more stopes, and looks after from ten to thirty boys. The miner tells the Kaffirs where to drill the holes, and attends to the loading and firing. A day's work for a drill boy is three feet, and the wages received are from 1s. 6d. to 1s. 8d.

Dykes and faults cause more or less trouble in mining on the Rand, but the main cross faults are becoming better known and are being carefully mapped. We may still look for trouble from faults and dykes parallel to the strike of the reef in the deep levels, but, while these dyke faults make dead work necessary, they usually effect an upthrow of the reef on the south side, bringing the reefs nearer the surface, and in some cases form an overlap, thus giving a gain of ore instead of a loss.

Ventilation. Ventilation is usually effected by natural draught, by means of two or more shafts, and from level to level through upraises. Artificial ventilation is often resorted to, especially in the developing mines, by means of blowing engines, or fans, operating sometimes on the vacuum, and sometimes on the plenum, method.

Sorting. There are few mines on the Rand where sorting in some form is not practised, at first roughly in the stopes, where the larger lumps of waste are picked out and thrown aside for filling, and again on the surface, aided generally by mechanical appliances. Surface sorting is done either at the headgears or at a central station, the latter practice being introduced almost entirely at the properties of the Rand Mines, Limited. The appliances are generally travelling belts, from 30 to 50 feet in length, or circular rotating tables about 30 feet in diameter. At some of the mines the sorting is done on floors. The ore is at first dumped over grizzlies inclined at angles of from 40° to 50° and set at $1\frac{1}{2}$ inches or more, according to the degree of fineness desired in the sorting. The material too coarse to pass through the bars slides on to the travelling belt, the rotating table, or the floor, as the case may be, where it is wet with a hose; as the belt or table moves, natives on either side pick out and throw into waste-bins the worthless quartzite, etc., the banket remaining being dumped into crushers of the Gates or Blake pattern set to three

inches or under, and going thence to the mill. Where sorting is done on the floor, the waste is picked out by natives, and the remaining banket is shovelled into the ore bins. At some mines, where the reefs are narrow, double sorting on round tables is being introduced. The ore is dumped from the skips, passing over two sets of grizzlies producing three sizes of material, the first or finest going direct to the mill, the middlings being sent to the second table, and the coarse material being delivered on a rotating table for the first sorting, going thence

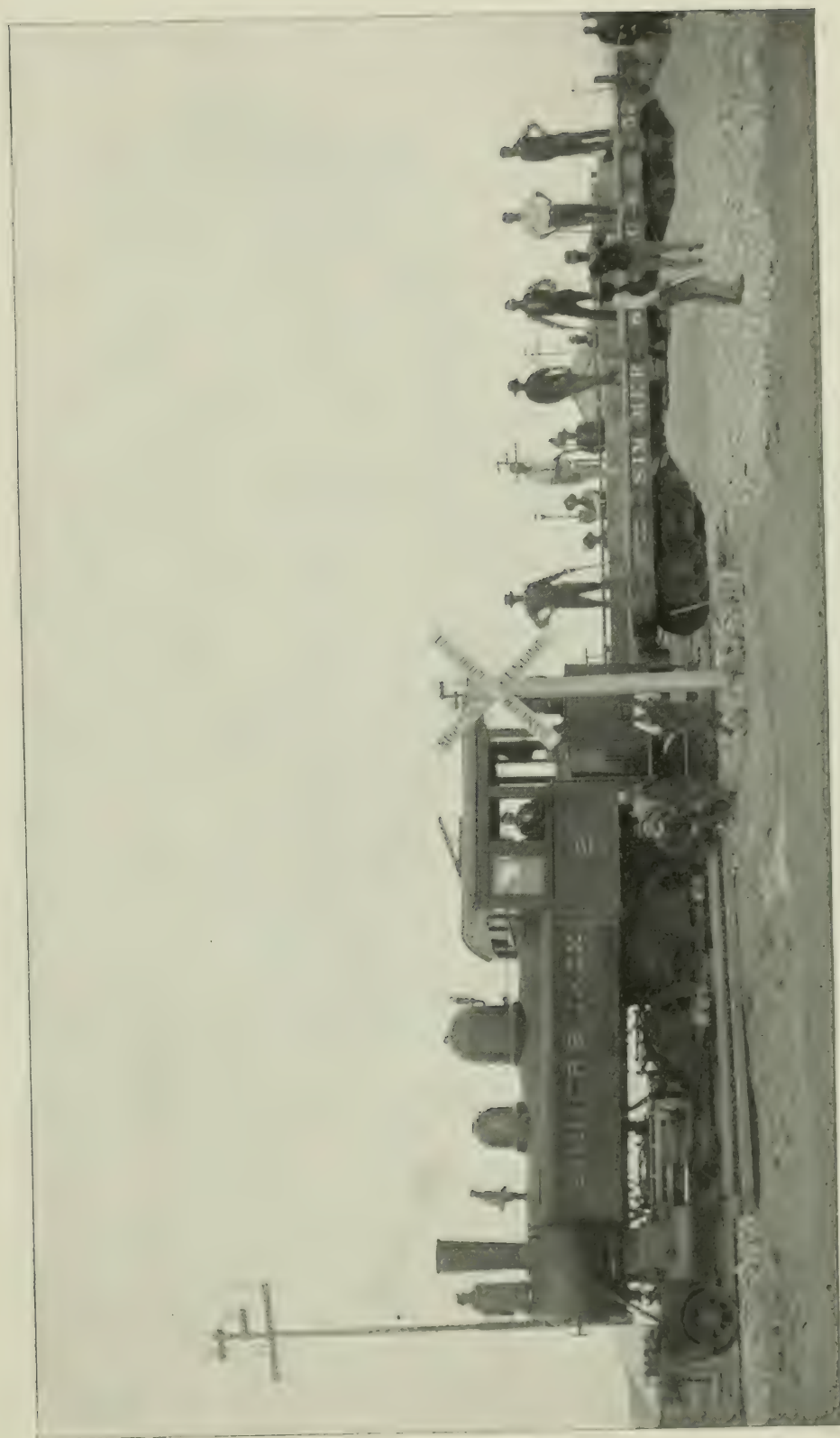


MECHANICAL HAULAGE BY ENDLESS TRAVELLING WIRE ROPES.

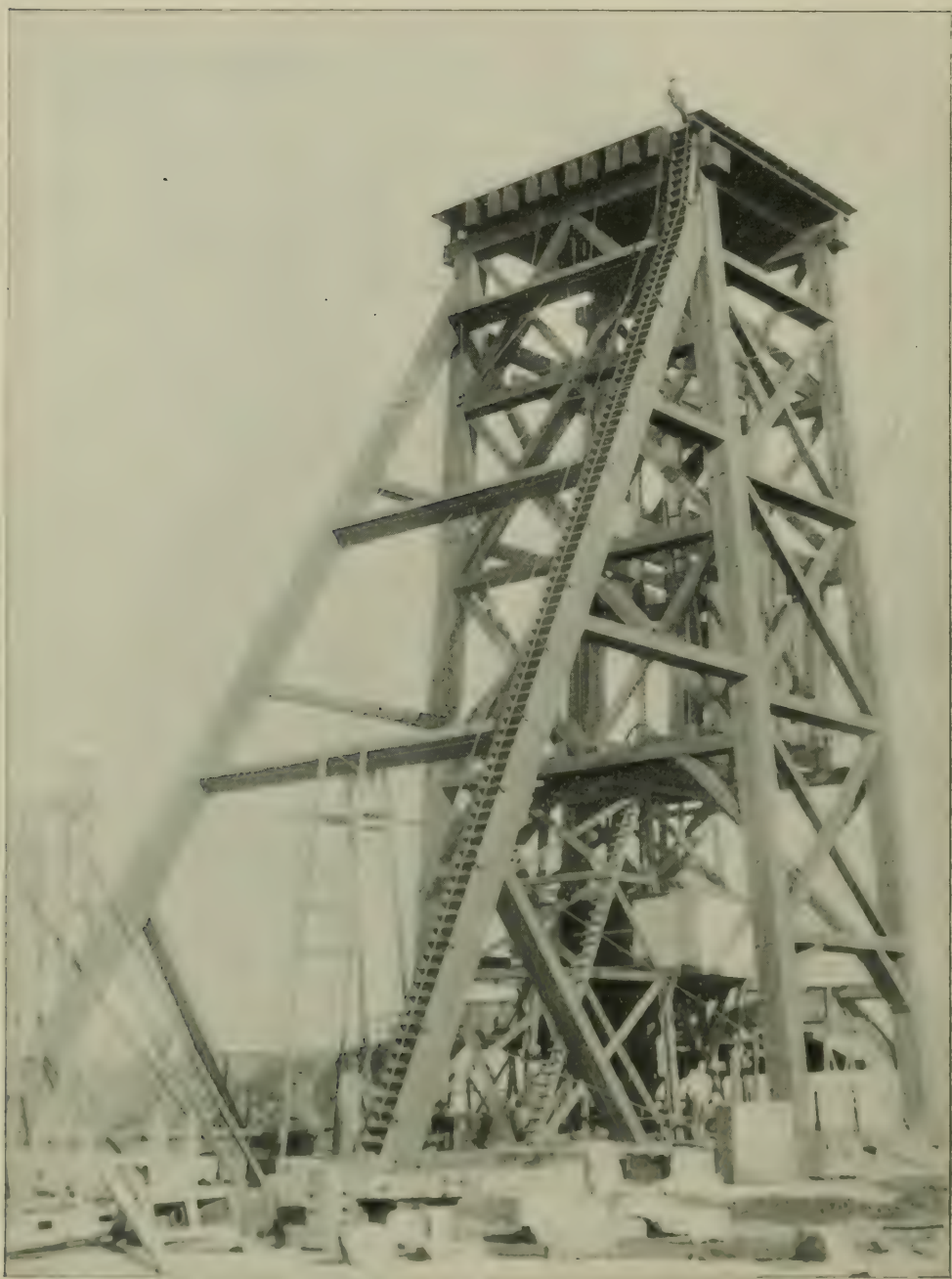
through crushers and over grizzlies to a second table for the second sorting, and again through crushers and to the mill.

The amount sorted out in a single operation varies, and, on an average, is probably from 12 to 16 per cent., though at the Ferreira the figure has sometimes risen to 40 per cent. on floors alone.

The percentage varies with different mines, according to the width of reefs and absence or presence of well-defined walls. The amount of fines made in the stopes is an important factor, and the use of machine drills materially lessens the percentage which can be sorted out by producing more fines in blasting.



MINE LOCOMOTIVE, SIMMER & JACK PROPRIETARY MINES.



WOODEN HEADGEAR, KNIGHTS DEEP GOLD-MINING COMPANY, LTD.

The costs of sorting and crushing with sorting tables and travelling belts vary from 5½d. to rs. or more per ton milled, depending on the amount sorted out. Maintenance in some of the older styles of belt is higher than with round tables. With revolving tables, crushing and sorting at the Geldenhuis Deep has averaged about 5.58d. per ton milled. With sorting on floors, where as much as

35½ per cent. of waste has been picked out, the cost of sorting alone has amounted to 10d. per ton of ore milled. At the Meyer & Charlton, on travelling belts, the cost per ton milled, for sorting and crushing, has been 5.54d.

Surface tramming is done by natives, mules, endless-rope haulage, in two or three cases by electric tram lines, and at the Simmer & Jack new plant by a thoroughly-equipped steam railway.

Headgears are generally of wood, and vary in height from 40 to 90 feet. A few steel relics of the early days, when all transport was



STEEL HEADGEAR, ROBINSON DEEP GOLD-MINING COMPANY.



AIR DRILLS ON INCLINE, NO. 1 SHAFT, SIMMER & JACK PROPRIETARY MINES.

from Kimberley by oxen, and wood was scarce, are still in use. Modern steel headgears, 85 feet in height, have been recently placed at both shafts of the Robinson Deep, but the present tendency is to wood, the cheaper first cost and ever more plentiful supply of large timber favouring this.

Where ore breaking and sorting are done at the shafts, the headgears are equipped with crushers, sorting appliances, ore bins, etc., making the cost considerably more than when they are used simply for hoisting.

Winding engines on the outcrops are of the double-cylinder geared type, but for nearly all the deep shafts direct-acting engines, of varying sizes, are being used. For the Simmer & Jack East compound-condensing winding engines have been ordered.

Boilers. According to the government report for 1896, there were 1,101 boilers on the gold mines of the Witwatersrand, with a heating surface of 809,743 square feet. These are of all types, and include locomotive, vertical, Lancashire, Cornish, etc. The horizontal multitubular, Babcock & Wilcox, and Heine are most favoured in the recent equipments. In an efficient plant the consumption of coal per i. h. p. is about 5 pounds, and the water evaporated is 6 to 7 pounds per pound of coal.

Compressors. The Ingersoll-Sergeant, Walker & Son, and Reidler are the ones most favoured in the more modern instalments. They are compound steam and air, and condensing, of from 20 to 30 drills' capacity at this altitude. There are other varieties, as the Rand, Yates & Thom, and Allis, of all capacities, with several of the vertical type.

At a recent meeting of the Society of Engineers and Architects, in Johannesburg, the following data as to cost of running air drills were presented by Mr. L. I. Seymour.

A King-Reidler compressor running thirty or thirty-one $3\frac{1}{4}$ -inch Ingersoll-Sergeant drills, and from one to five air-driven pumps, for three months, showed an average of less than 9 actual h. p. per drill, exerted continuously by the compressor.

The average depth of hole drilled per shift was from 20 to 24 feet. The total cost per drill per month was £119 14s. 9d., distributed over cost of coal, stores, repairs, spare parts, repairs to compressor and boilers, labour (white and black), sharpening bits and cost of steel, interest on plant, and redemption at 12 per cent. of original cost.

At every mine on the Rand provision is made for more or less lighting by electricity, and in many instances an installation for some power, such as pumps, haulage, and various isolated small motors.

At Brakpan, adjacent to the coal mines, the Rand Central Electric Works have been established, for the purpose of selling power to the various mines along the line of reefs. The current is three-phase, of low tension, and is raised by transformers to 10,000 volts.

For supplying electric power to several of the deep mines of the Consolidated Gold Fields of South Africa, Limited, a plant is under erection on the three-phase system, three 500-k.w. generators being at present installed.

Coal is abundant, and is in close proximity to the mines, to which good fortune the gold-mining industry is greatly indebted for its success. The seams lie near the surface, and are generally of unusual thickness, and can be cheaply mined. The quality is somewhat inferior, having a high percentage of ash. According to the State mining engineer's report, 863,811 tons were consumed in 1896 at an average cost of 19s. 1d. per ton, freight being about 3½d. per ton per mile. With few exceptions, coal is delivered to the mines in bags of about 200 pounds capacity. The cost of coal is between 7 and 9 per cent. of total working costs.

This review of the mechanical features of the equipment and operators will be supplemented, in the succeeding number of the Magazine, by a discussion of the conditions of labour, supplies, and economic features of mining on the Rand.

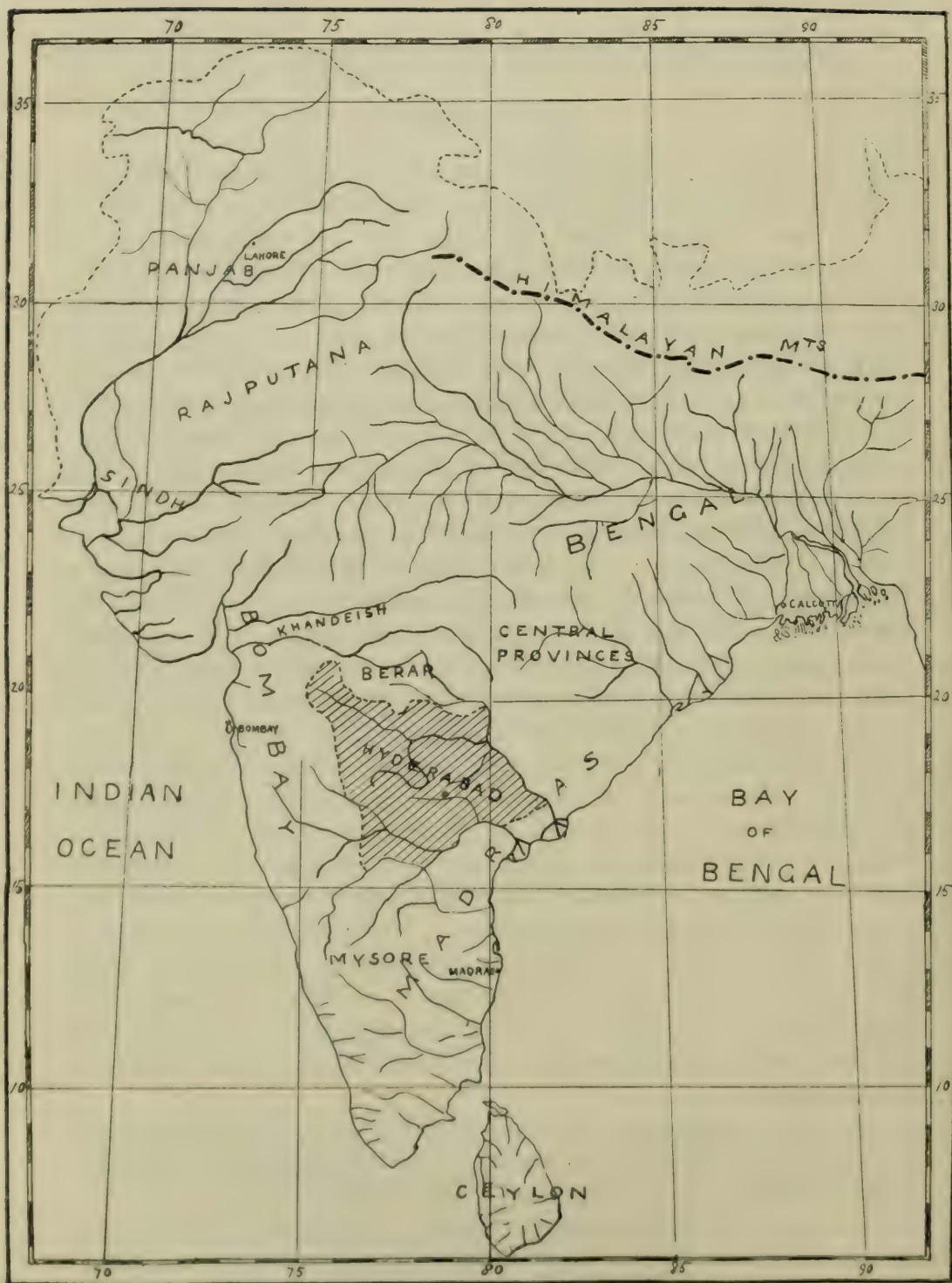
TANK IRRIGATION IN CENTRAL INDIA.

By G. Palmer.

THE State of Hyderabad (or the Nizam's Dominions) lies between 15° and $20\frac{1}{2}^{\circ}$ north latitude and $74\frac{1}{2}^{\circ}$ and $81\frac{1}{2}^{\circ}$ east longitude; see map (Fig. 1). It covers an area of 82,698 square miles, or about one-twentieth of the area of India subject to British rule or influence. The western boundary of the State runs parallel with the western Ghats, and lies at levels of about 2,000 feet above the sea at the northern extremity and about 1,400 feet at the southern. The country may be considered as a fairly level table-land for three-quarters of its width from west to east, sloping afterwards somewhat rapidly to a level of about two hundred feet in the valleys of the Godavery and Kistna rivers. Along the western boundary, and for about half the width of the State, the country is open and undulating. The broad valley of the Godavery is deep in alluvial soil, and the land is productive in dry crops. The hills in the north-west, which rise to 2,500, and in some instances to more than 3,000, feet, are basaltic; they fall abruptly into the plains of Khandeish and Berar on the north. Over the eastern half of the State are ranges of gneissic formation, attaining heights of from 200 to 500 feet, and occasionally reaching 1,000 feet above the ordinary level of the land. Time and the process of weathering have disintegrated the gneiss, which may be seen in every stage of the process, from huge piles of boulders, in appearance as if heaped up by primeval giants, to gravel, or moorum, and ultimately to red earthy soil, fertile and well suited for wet cultivation. A band of limestone, belonging to what is known as the Kurnul Series, runs east and west, some fifty miles wide, across the western half of the State,—a hard, laminated stone, extremely useful for building purposes. Iron stone hills and coal-measures exist on the eastern side of the State, bordering the Godavery.

Roughly speaking, in the western half of the country black cotton soil chiefly prevails, the result of the disintegration of basaltic rocks. In this soil successful cultivation depends only on the rain that soaks into it in the monsoon season; the crops are cereals, cotton, grain, castor, linseed, and other oil plants. These are called dry crops. In the eastern half of the country the red earth, the result of the disintegration of gneiss, is most suitable for the cultivation of rice and sugar cane, which are essentially wet crops.

The capital of the State, the city of Hyderabad, is situated about



MAP OF INDIA.

The shaded portion represents the Hyderabad State.

FIG. I.

midway between the eastern and western boundaries and one-third way from the south between the southern and northern. The dotted line shown on the map (Fig. 2) divides the country where wet cultivation abounds from that in which dry cultivation is mostly practised. It is not to be supposed that there are no irrigated crops on the western side of that line, but, as we proceed west and north, we find that irrigation works get rapidly fewer, and disappear as we approach the boundaries. Irrigation on a small scale, by the water supplied from



FIG. 2. MAP OF THE HYDERABAD STATE.

The irrigation district lies to the east of the dotted line. Round dots indicate rain gauges.

wells, exists everywhere, but this is confined to small patches, and, with the exception of an occasional acre or so of sugar cane, to little more than garden produce.

The two principal rivers are the Godavery and the Kistna, both rising in the western Ghats and flowing eastward into the gulf of Bengal. The Godavery has several large tributaries, among them the Sivenna, the Manjera, and the Manair, all of which drain extensive

tracts of country, the main river below Sironcha forming the boundary between the Hyderabad State and the central provinces. The chief tributaries of the Kistna are the Bheema and the Toongabudra. The former rises in the Ghauts, to the east of Bombay, and the latter has its source some 350 miles further south. They both join the Kistna in the south-west corner of the State. The Toongabudra and the Kistna form the southern boundary of the State for nearly 400 miles. The Godavery and its tributaries drain some 45,000 square miles of country, and the Toongabudra and Kistna 4,500 and 19,000 square miles respectively. Enormous volumes of water, therefore, are carried off by these rivers during the rainy season, and their extreme importance in regard to irrigation works on a large scale is at once apparent.

To describe to how small an extent they have as yet been used in this connection, so far at least as the Hyderabad State is concerned, and to how great an extent they might be so used, would unduly swell the limits of this article. The whole area of the Hyderabad State is divided, for purposes of administration, into eighteen districts, or "Zillahs," which are grouped in four divisions, or "Subas." These divisions are the central and northern, called the Bidar division; the eastern, or Warangal; the western, or Aurungabad; and the southern, or Gulburgah. The average size of a district is 4,600 square miles, or a little more than three times the average size of a county in Great Britain, and that of a division is more than 20,000 square miles. The administration is conducted on lines similar to those prevailing in British India. A taluqdar governs a district, and a subadar a division; these are responsible, through secretaries of departments, to the prime minister, who, aided by a cabinet council, is answerable to H. H. the Nizam, the ruler of the country. The boundaries of divisions are roughly shown in the map (Fig. 2).

As in British India, the principal revenue is derived from the land. Certain areas of land are crown-lands, or the private property of the ruler of the State; certain others are held by noblemen and gentry of the country, under grants made to them by former rulers. The area of all these may amount to one-fifth of the total area, and the government is considered to be the owner of the rest. It is let out to the cultivators at rates, per acre per annum, proportionate to the productive value of the soil.

In districts where irrigation is practised the government provides and maintains the necessary works, and of course levies a heavier assessment, that for wet—*i. e.*, irrigated—crops being, on the average, nearly nine times that for dry crops.

Until within the last thirty years the assessment was somewhat

irregular, and fluctuated with the needs of government, the favourable-ness of the seasons, or the zeal of the local collectors, and the revenues of much of the land were even farmed out to contractors; but in recent years the example of British India has been followed, the cultivated and cultivable areas have been accurately surveyed, and each field has been carefully assessed. The assessment holds good for thirty years, when it is liable to revision. The cultivator has now a sure knowledge of the amount of rent he will have to pay, and knows also that he will be the chief participator in the benefits of a good season. On the other hand, of course, the brunt of a bad season falls upon him, but here a paternal government comes to his aid, and, when a scarcity of rain prevents his raising sufficient crops even to pay his small rent, it remits a part, or even the whole, or allows it to stand in abeyance. Also, when worst comes to worst and famine prevails in the land, relief-works are started for those whose customary occupations are at a standstill, and every possible measure is taken to mitigate the horrors of scarcity and starvation. In the famine of 1876-77 the loss in government revenue amounted to R7,000,000, and this at a time when the total revenue did not exceed two-thirds of what it is at the present day.

Hyderabad, like the rest of the centre and south of India, depends for its prosperity on the south-west monsoon. This, setting in in Ceylon soon after the middle of May, works its way up the west coast, and, overcoming, as it gains its full strength, the barrier of the western Ghauts, advances steadily across the Deccan. Its normal date for reaching the Hyderabad State is June 5. It continues, with the wind prevailing from the south-west, till beyond the middle of September, when the wind, gradually veering round by west and north to the north-east, brings what appears to be a return monsoon, but what probably is the current of the south-west monsoon, which, passing, from the commencement of the rains in June, up the east coast and thence to the north-west up the Gangetic valley, has attained greater strength than that which is then exercised by the waning west coast current, and makes itself felt in the central provinces and the south. To this return current Hyderabad is often indebted for heavy falls that save the country from the scarcity that might follow a lack of strength in the original south-west current. The real north-east monsoon, so favorable to the Madras presidency, does not set in till a later date,—the end of October. It occasionally brings rain, and sometimes heavy rain, to Hyderabad, but is not to be relied upon. In November, 1896, however, after a very poor south-west monsoon, scarcity and distress, which had begun to be felt in Hyderabad, were much mitigated, and the outbreak of real

RAINFALL. (Inches and hundredths.)

Divisions.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	Average per year.
Hyderabad	19.10	32.98	47.44	39.71	31.04	27.15	37.94	30.83	32.62	35.73	34.45	28.38	18.46	39.17	34.87	17.59	51.18	32.86
(city and suburbs.)	21.45	28.49	44.88	32.35	32.81	30.44	35.01	55.85	44.11	41.23	53.26	31.49	28.58	38.81	39.03	28.13	53.81	37.63
Northern	15.55	25.70	42.17	32.52	27.23	22.78	29.98	35.87	30.07	29.92	37.39	25.86	25.15	35.77	28.87	23.80	46.12	30.28
Eastern	11.25	28.34	40.99	29.50	30.84	25.46	29.35	34.34	23.00	31.95	37.36	30.81	23.84	31.30	31.59	16.31	45.21	29.50
Southern	20.70	19.02	39.44	35.03	32.37	28.54	37.75	40.46	34.31	27.24	39.72	36.06	28.17	41.54	36.35	36.84	49.42	34.72
Western																		

FIG. 3. TABLE OF RAIN-GAUGE RECORDS FROM HYDERABAD STATIONS.

famine was probably prevented, by the timely fall, during one week, of about three inches of rain, extending pretty generally over the whole State. As a rule, after the beginning of November very little rain falls in Hyderabad, till June again brings the south-west monsoon. A few light showers may occur about Christmas time, and the intense dry heat of March, April, and May may be relieved once or twice by slight falls; but these do little more than temporarily improve the precarious pasturage for village sheep and goats, and in the towns they but “bring out the smells,” and are of questionable benefit from a sanitary point of view.

The features of the rain-fall during the monsoon season are very varied, and naturally of great interest to those concerned in the welfare of the State. Rain-gauges are kept at the chief town of each district, and at the head-quarters of each “taluk,” or sub division of a district. Thus about 126 gauges are distributed with fair uniformity over the State, giving to each gauge an average of about 650 square miles. The gauges whose records are most to be relied upon are those at the district chief-towns. These records are reliable from 1876, and the table (Fig. 3) gives the yearly results at the city of Hyderabad itself, and in the four divisions for the seventeen years from 1876 to 1892. The positions of the gauges are shown by round black dots in the map (Fig. 2) and, though in each year the rainfall may vary considerably among the districts composing a division, it may be assumed that practically the same meteorological conditions prevail over the whole of one division, and that the

general average applies pretty nearly to each of its districts. Space hardly permits the details of each district to be shown here, but it is well to give the averages over the seventeen years, in order to show, against local variations, the general uniformity of the rainfall over the

RAINFALL (inches and hundredths).

Districts.		Average of 17 years from '76 to 1892.	Wet or dry cultivation prevailing.	Heaviest rainfall in a year.	Year.	Least rainfall in a year.	Year.
Western " Southern " Eastern " Northern " Division.	Hyderabad.....	32.86	wet	51.18	1892	17.59	1891
	Bidar.....	42.64	dry	70.00	1883	21.37	1876
	Mehdad.....	35.57	wet	64.34	1892	21.45	1876
	Indur.....	39.01	wet	60.47	1886	25.43	1879
	Elgandal.....	33.37	wet	51.94	1886	17.98	1891
	Warangal.....	32.52	wet	45.26	1883	16.86	1881 ¹
	Nalgunda.....	27.04	wet	49.19	1892	14.24	1876 ²
	Mahbubnagar.....	31.29	wet	55.40	1892	13.11	1876 ³
	Raichur.....	26.64	partly wet	50.02	1892	12.27	1881 ⁴
	Lingsugur.....	25.42	dry	38.94	1878	5.45	1876 ⁵
	Gulbarga.....	28.96	partly wet	43.63	1892	12.38	1876 ⁶
	Nuldrug.....	36.99	dry	50.01	1886	14.06	1876 ⁷
	Bhir.....	32.46	dry	51.45	1883	17.94	1876 ⁸
	Aurangabad.....	32.61	dry	50.81	1882	18.37	1876
	Parbhani.....	34.13	dry	51.19	1892	16.26	1877
	Nander.....	39.67	partly wet	58.83	1891	13.65	1877

¹ Scarcity in 1876-77.

² ditto nearly amounting to famine and the same in 1891.

³ ditto ditto scarcity in 1891.

⁴ Famine in 1876-77. Scarcity in 1891.

⁵ ditto ditto

⁶ ditto ditto

⁷ ditto

⁸ ditto in parts.

Assuming a general average throughout the country of 33 inches, the averages per month should be, in the most favorable monsoons, as follows :

January.....	2 in.	May.....	1 in.	September.....	8 in.
February.....	2 "	June.....	5 "	October.....	2 "
March.....	2 "	July.....	6 "	November.....	1 "
April.....	2 "	August.....	8 "	December.....	1 "

33

FIG. 4. AVERAGE RAINFALL FOR SEVENTEEN YEARS.

whole State, and that the rainfall above does not determine the nature of the cultivation (wet or dry) prevailing in each district. The table above (Fig. 4) gives this information.

It will be seen that the highest district average is that of Bidar in the northern division, a dry cultivation district ; the next that of Nander in the western division, also a dry district ; then come Indur in the northern division, a wet cultivation district, and Nulding in the

southern division, a dry district. The lowest is Lingsugur, in the southern division, a dry district, whose average is only an inch below that of the neighbouring district of Raichur, a dry district, in which there is a slight sprinkling of irrigation works.

Irrigation works prevail chiefly in the districts of the northern and eastern divisions, are much less common in those of the southern division, and scarcely exist in the western.

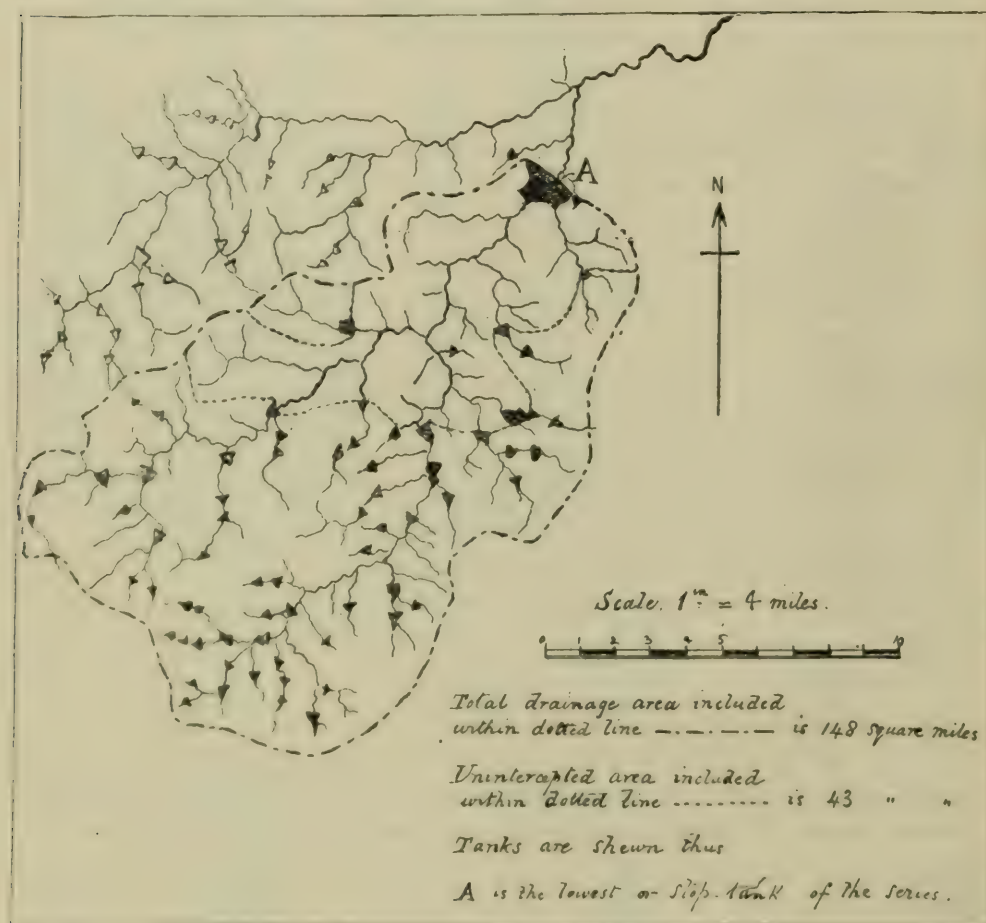


FIG. 5. A TYPICAL SYSTEM OF IRRIGATION TANKS.

The system of irrigation is mostly that known as the ancient Hindu system of tanks. The word "tank," in an Indian irrigation sense, means a storage reservoir. A tank has no definite size; its area of water-spread may be two or three acres, or it may extend to as many square miles; its depth may be 3 or 4 feet, or 100 feet, or more.

The word "Koonta" is used in Hyderabad to signify a very small tank, such as one of two or three acres only. The words "Sangor" and "Cherroo" are the Hindustani and Telugu equiva-

ents, respectively, of the word that has been coined into English as 'tank.'

Down every valley a stream must flow in the rainy season, its size depending upon the area of the ground that drains into it. A small stream is a feeder, or one of several feeders, to a larger stream, whose drainage area is the total of those of its small stream feeders. The larger stream is again but a feeder to one still larger, and so on till the great river is reached that carries the water from the whole accumulated drainage areas to the sea. In each little valley, in each larger valley, in each yet larger valley again, one or more tanks can be constructed, and thus the drainage area supplying a tank may vary from less than one square mile to one hundred square miles. It is not often that a tank has a drainage area of one hundred miles unintercepted,—that is to say, without numerous other tanks in the smaller valleys above it, which, if properly constructed and kept in repair, mitigate the rush of the large body of water that would otherwise flow directly into it. The danger to a large tank at the end of a series, when, by the breaking of the tanks above, the advantages of interception have been lost, may easily be conceived. In the Hyderabad State there are instances of tanks impounding water from very large areas, but space does not permit me to deal with them here.

The map (Fig. 5) shows a series of tanks covering an area of 148 square miles, and draining into a large stop-tank at the end. The area here illustrated embraces the upper branches of a large feeder of the river Moosey, which is itself an important feeder of the Kistna.

This series is typical of the system,—details of size, number, and arrangement of the tanks being, of course, subject to wide modification according to the topographical features and agricultural conditions of a district. The tank is the unit, the special consideration of which, in its engineering and economic aspects, is reserved for a succeeding article.

THE INTERPRETATION OF SANITARY WATER ANALYSES.

By Floyd Davis.

THE impurities that affect the quality of water for domestic purposes are inorganic and decomposing vegetable and animal matter and the micro-organisms of disease. Some of these exist in harmful quantities in the water of many streams, and in other sources that flow through, or originate in, rich agricultural or swampy land and densely-populated districts. A small amount of fine, non-silicious mud or silt in drinking-water is not known to produce disease, and is objectionable only from an æsthetic standpoint. But the large amount of angular particles of sand and decaying vegetation found in some streams is frequently productive of intestinal disturbances, like inflammation of the bowels, diarrhoea, and dysentery; and any water that is distinctly turbid should be regarded as non-potable, until it has been clarified and freed of its organic matter.

At certain seasons some algæ produce a disagreeable taste and odor that make it unpleasant to drink water containing them, while nearly all decaying vegetable matter favors the production of intermittent and malarial fevers. Malaria was once thought to be only of aerial origin, but the foremost investigators now attribute it also to stagnant water, containing an abundance of decaying vegetable matter. The celebrated case of the *Argo*, and the investigations made by Dr. Richard H. Lewis, of North Carolina, and others, show in many cases the water-origin of this disease; and malaria is liable to exist wherever the temperature is high, the vegetable growth large, and the country low and flat.

As people gain knowledge in sanitary science, many of these impure waters are abandoned in favor of deep wells, or they are mechanically purified, generally with the happiest results in reducing the number of fever cases, or in the entire eradication of the disease. While impure water is thus productive of malaria, the fever is not directly attributable to organic matter; it is produced by a protozoon, the *plasmodium malarie* of *Laveran*, which is supposed to exist in and about impure surface waters, although the organism is rarely found outside the human body. Insects that inhabit swamps and stagnant ponds may also be instrumental in propagating this fever, since the common mosquito is now regarded as the host of the malarial germ, sometimes transferring it to persons susceptible to the disease.

Far more important and dangerous, however, than mineral and vegetable matter is animal refuse, such as sewage and drainage from cess-pools and privies. This not only furnishes a favorable pabulum for the growth and development of micro-organisms, but also opens an avenue to the system for admission of infection; and drinking-water contaminated with sewage is intimately connected with disease, as well as objectionable from an æsthetic standpoint. There is a vast difference, however, between the infectious nature of sewage in its fresh condition and that of sewage which has undergone complete chemical change. So long as it remains as sewage,—*i. e.*, retains its original nitrogenous ingredients not completely converted into new compounds,—it is liable to be disease-producing. Among the numerous bacteria of its earlier existence there are probably some that are harmful, and the sewage environment may so modify others as to render them pathogenic. But through the effects of dilution, precipitation, oxidation, and nitrification, these ingredients gradually disappear from contaminated water; still, we cannot rely on the disappearance of the most harmful agents at any given time, or under any given condition, for it is now well-known that the self-purification of water, so far as bacteria are concerned, is much less than was once supposed.

Still, under nature's agencies, polluted water may be so improved that the factor of danger becomes inappreciably small, and it may then be drunk with the same assurance of safety that prevails when we eat or breathe. Hence it will be seen that *pure* and *impure*, like *normal* and *abnormal*, waters are distinguished only by the amount of certain constituents common to all, and it is true that nearly all natural waters have some foreign substances which would condemn them, were they present in sufficient quantity. From the nature and effect of this extraneous matter, it is evident that a drinking-water should be considered *pure* only when practically free from decomposing vegetation, and absolutely free from fresh products of the human body. So sanitarians have learned that it is not so much the *quantity* as the *quality* of the impurities in water that determines its suitability for drinking, and the foremost investigators uniformly condemn all waters that are in the least contaminated with *fresh* sewage. Even after sewage has been changed by oxidation to its final products, there may be danger from the use of water containing it, on account of its germs. This is especially true with surface waters originating in a gravel and limestone soil, for the organic matter is changed to nitrates more rapidly than the bacteria are removed. And, as typhoid fever and cholera are well-known to be produced by infectious bacteria which accompany sewage, it is important, in interpreting

every sanitary water analysis, to keep in mind the changes through which sewage passes under the action of the constituents of the soil.

A water is pure and wholesome when it meets all the requirements of the body in absorption and elimination, even in the most delicate constitutions. But some waters have unpleasant taste from mineral and decaying organic constituents; some have unsightly appearance from color or suspended matter; some have disagreeable or disgusting odor; while others are so charged with inorganic salts that the kidneys are overworked in eliminating the waste products of the body. All these objectionable waters should be regarded as impure, and they are certainly unwholesome, because the system rebels against anything which is not approved by the senses of sight, taste, and smell. Such water is sometimes forced upon a community until public necessity compels it to be abandoned in favor of a pure and wholesome supply. We are safe in going still further, for, when a water is even liable to become contaminated with sewage, it should be guarded against with the same care that is exercised in dealing with the most dangerous poisons.

The diseases that are known to be produced by impure water are Asiatic cholera, typhoid fever, malaria, diarrhoea, dysentery, and some other intestinal disorders. These diseases are either the result of an irritant, or are produced by bacteria or other micro-organisms, and it seems at first thought that an investigation to determine the wholesomeness and suitability of water for domestic use should consist in searching for the immediate agents of disease. But experience shows that the bacteria in water are so numerous, and so resemble one another, that the harmful micro-organisms, even in the most contaminated waters, are but a small proportion of those that are present. Their determination requires the most careful study and patience, and much time, and the results are generally negative and unsatisfactory. So, in ascertaining the sanitary quality of a water, it is safer, as well as easier, to determine the organic impurities, like sewage, than the bacteria, for the pathogenic micro-organisms exist only in natural water that has, or once had, measurable quantities of organic matter. The amount of water required for a chemical and microscopical analysis is so large that any foreign matter which might exist in the general supply would, in all probability, also exist in the sample operated on; and the determination of sewage shows the possibility of accompanying dangerous micro-organisms. In sanitary water investigations it is not customary, therefore, to search for pathogenic germs, but to determine irritating substances and other associations and conditions that favor disease. This is done principally by chemical and microscopical analyses, and, in the testing of

filters, by additional bacteriological examinations of the water. But a thorough investigation of a public water-supply should always involve a sanitary survey of the surrounding country to determine the contaminating agencies. Sometimes also study of statistics will show a relation between death-rate and quality of water-supply ; and in all this work much depends upon proper interpretation of the results.

The Sanitary Survey.

A sanitary survey will sometimes reveal enough pollution to condemn a water, no matter how small the amount of organic matter and how low the number of bacteria found in it. Whenever there are visible sources of filth, the water should not be used for drinking in its natural condition, especially when any of the pollution is sewage. Every season brings to our attention many cases of disease attributable to impure water, where the contamination is visible and might have been removed ; and so the opinion grows stronger, year after year, that, by applying an ounce of prevention to the discovery and removal of pollution, pounds of cure would never be needed. It is always necessary to know the origin of a water that shows but little organic matter, before giving even a conditional final opinion of its quality for drinking, and the results should be compared with local standards of permissible impurity. The free ammonia sometimes found in deep wells would condemn a surface water without further study, and yet in the deep-seated water it is permissible ; and the chlorine and nitrates of some mineral waters greatly exceed the permissible limits of those found at the surface. Many polluted waters found in limestone soil are free from organic matter, because this has been oxidized to harmless products ; and, if we rely entirely upon our reagents and microscopes, without regard to chemical change or source, we generally pass too favorably upon the water.

In forming an opinion from the sanitary survey, it is always safe to condemn a water which shows visible contamination beyond a reasonable limit of æsthetic permissibility ; yet, when laboratory methods fail to find organic matter, or its associations, in water, we are not warranted in pronouncing it good, unless we know that these have never existed in it. The most that can be said in favor of the water is purely negative. On the other hand, it is often proper to condemn surface waters, even by the sanitary survey alone ; but it is unwise for a chemist to rely very much upon the investigations made by inexperienced men. The most competent investigators give an opinion only after an examination of the source of supply and the whole drainage area, made by themselves or by others equally skilled.

The Chemical Analysis.

A chemical analysis determines the present and past pollution of

a water, and generally distinguishes between vegetable and animal matter, and, when the results are properly interpreted in the light of the sanitary survey, they often show whether a water is unsafe for drinking. Sanitary water analyses are usually reported in parts per million, so far as chemical results are concerned, because a litre of pure water at its maximum density contains exactly 1,000,000 milligrammes.

The total solids should not exceed 1,000 parts per 1,000,000 parts of the water, because the use of such water overworks the kidneys in removing the waste products from the body. The best drinking-waters contain usually not more than 500 or 600 parts of solid matter, which amount is nearly constant at all seasons of the year, and in all parts of a distributing water-works system; and it is not until this amount is exceeded that the water usually reveals the excess through the taste of its salts. Any decided variation from constancy in the amount of solids generally represents contamination and faulty management, and this is so marked in the water from "dead ends" that we sometimes find from thirty to forty times as much solid matter here as exists in the normal supply of the plant.

Loss on ignition, as determined by the refined methods adopted by some chemists, is not of especial interest to the sanitarian, since the principal value to be ascribed to this determination is from the qualitative indications of color and odor evolved. A blackening of the residue indicates organic matter, which disappears somewhat in proportion to its instability, and, when it evolves little or no odor, the organic matter is probably of vegetable origin. But, when the odor is strong and disagreeable, the contamination is generally from animal sources, or is highly concentrated, and the water requires no further investigation to show that it is polluted and unfit for domestic use.

The chlorine in ground waters or in uncontaminated streams is generally small, and is constant at the same season in all parts of a distributing water-works system; its amount should be nearly the same as that of the normal chlorine in other pure waters near by. Immediately after heavy rains, the amount is greatly reduced by dilution, and during a drouth it is excessive, but is the same at all points in one locality. Any variation from constancy in the amount of this element should be studied with care, and its cause ascertained. Chlorine is in this way an important means of detecting sewage contamination, but it is of no aid whatever in detecting vegetable refuse.

In an investigation of a public water-supply all tributary streams and rivulets should be examined; whenever marked variations in the chlorine occur, they are generally due to animal contamination, or to saline deposits near by. But the absence of this element, its small

amount, or its constancy in a water is absolutely no evidence that the water is pure and wholesome, because vegetable matter, which is practically free from it, may be there in any proportion, and thus render the water unfit for domestic use.

Free ammonia in water represents albuminous matter in a decomposing condition, and, when this is of vegetable origin, it is often noticeable, in Nesslerizing for the free and albuminoid ammonia, that the color is decidedly yellowish-green, instead of chocolate, and is especially distinct after the second or third fifty-cubic centimeter distillate. When the water contains urea, derived from urine, the organic matter is slowly decomposed, and the rate of distillation of the free and albuminoid ammonia becomes nearly constant after the first fifty cubic centimeters of each have been evolved; and a few of the last fractional distillates of albuminoid ammonia show nearly twice as much as the corresponding ones of the free. These facts are often of great service in detecting fresh sewage pollution. Surface waters suitable for drinking contain usually not more than .050 part of free ammonia to 1,000,000 parts of water, and often much less when the albuminoid exceeds this limit.

Albuminoid ammonia is developed from undecomposed nitrogenous substances when under the influence of a boiling solution of alkaline permanganate, and therefore represents pollution in a fresh and possibly dangerous condition. When a large proportion of this is evolved in the first part of the distillation, the organic matter is very unstable and in a putrefactive state, and, whenever the total free ammonia exceeds the albuminoid, the water, if it be a surface one, is generally stagnant and insufficiently aerated, and a suspicion is always entertained of sewage contamination in an advanced decaying condition. Waters that contain less than .050 part of albuminoid ammonia per 1,000,000 parts of water are organically nearly pure, and may generally be considered permissible, unless their origin is sufficient to condemn them; those that contain from .050 to .100 part are really dirty; while those that contain more than .150 part of albuminoid ammonia should be condemned as unsafe for human consumption. In an investigation of a recent typhoid-fever epidemic at Duluth, Minnesota, where two thousand persons fell victims to the disease, the city water, which was its cause, contained only .090 part of albuminoid ammonia per 1,000,000 parts of water. This one case shows how small an amount of albuminoid ammonia may be indicative of sewage pollution.

The oxygen consumed is generally in proportion to the carbon and hydrogen present in the organic matter of the water, and it often enables us to distinguish between vegetable and animal contamina-

tion. Permissible waters usually require not more than $1\frac{1}{2}$ to 2 parts of oxygen per 1,000,000 to destroy their organic matter, and, when the amount exceeds $3\frac{1}{2}$ or 4 parts, the water should be considered with suspicion. Whenever the amount of oxygen consumed is comparatively large and the albuminoid ammonia small, the contamination is usually of vegetable origin, and, when the oxygen is small and albuminoid ammonia large, the organic impurities are either of animal origin or concentrated albuminoids derived from vegetation.

Nitrites are compounds formed by the oxidation of ammonia in presence of weak bases, or are produced from nitrates through organic decay and bacterial action. They are very unstable salts, and frequently exist in cemetery drainage and badly-polluted surface waters. Any water having nitrites in measurable quantity should be regarded with suspicion, and many surface waters should be condemned by their presence alone.

Nitrates are the final products of oxidation of the nitrogen of organic matter, and therefore represent past pollution. Their normal amount in permissible water is generally very small, often-times not exceeding a mere trace, and their presence in a stream, or in the distributing system of a water works, in amounts above that of the original water supplying it, or the ground water near by, is evidence of contamination. This pollution is often due to faulty management in allowing suspended matter to accumulate in the mains; all "dead ends" should be flushed at frequent intervals.

The Microscopical Examination.

Under the microscope the suspended matter which separates from a water upon standing, like silt and other substances which might irritate the intestinal tract, can be studied with precision, and the results are often of great value in determining its sanitary quality. The writer has detected, in wells and streams used for domestic supply, particles of hair, excreta, oil globules, epithelia, and other filth derived from surface drainage or sewage, such as decaying vegetation, and it requires no argument to show that all such water is loathsome and unfit for domestic purposes. The microscope also enables us to study algæ and the animal micro organisms of water, such as paramecia and other sewage ciliata which have been traced directly from the source of contamination to the point of supply; and we thus judge of the character of the water by knowing the habitat of these micro-organisms. The various entomostraca, such as cyclops and daphnia, can also be best studied with the microscope, although they can be easily seen with the naked eye. These organisms were once held as indicative of purity, but they are also found in water contaminated with drainage and we now know that their presence has no significance.

The Bacteriological Examination.

Bacteriology offers considerable service in the study of a water-supply, by determining the number of micro-organisms in a given volume of it. This science is particularly valuable in ascertaining the efficiency of filtration, and it also sheds some light on nearly all natural waters. Those from exceptionally pure sources, such as springs, deep wells, and rain or snow that falls at the end of storms, have but few bacteria in them, and the best ground and surface waters usually contain no more than 200 or 300 per cubic centimeter. The number of micro-organisms generally increases with pollution, until sewage is reached, with its millions per unit volume; and, when there is a large number of sewage bacteria, it is probable that pathogenic germs are among the lot.

Since bacteria are absorbed from the air, the best surface waters must contain them, and no fixed standard of permissible limit is given. The number of micro-organisms depends entirely upon local conditions, always being more in thickly-populated districts than in mountainous and uninhabited regions. But some eminent authorities hold that a drinking-water should not contain more than 1,000 germs per cubic centimeter, and the sanitary authorities of some large cities, having municipal water works, advise the inhabitants to boil the water whenever the number of bacteria in it exceeds this limit. Systematic tests are frequently made to ascertain efficiency of filtration by determining the number of micro-organisms in the unfiltered and effluent waters; and mechanical filters are now operated so perfectly by the use of alum cake as a coagulant that from 97 to 98 per cent. of the bacteria are removed. Some filter companies now guarantee to remove 96 per cent. of the micro-organisms, and reduce the albuminoid ammonia at least to .150 part per 1,000,000 parts of the water, and any system of purification that falls short of these results is unsatisfactory in proportion to the degree of failure.

Some investigators attempt to determine the wholesomeness of water by searching for its pathogenic germs, while others inoculate guinea pigs and rabbits with a culture medium which has been impregnated with the water and kept at the temperature of the human body for some time, and then study the effect with a hope that, if the water is disease-producing, physiological symptoms will develop characteristic of disease. But the numerous and tedious operations required for the identification of any species of bacteria, and the improbability of finding it, render the search almost hopeless at the beginning and usually fruitless in the end. This is not strange when it is remembered that only a few drops of water are operated on at a time. No polluted water, or even sewage, is teeming with disease-

producing germs, and they can be expected only in very inconsiderable numbers compared with those of other bacteria present.

There are but few cases on record where the Eberth bacillus has been satisfactorily isolated from water-supplies, and it is doubtful whether there has been a case on the American continent. The resemblance of this bacillus to certain water bacteria has often confused inexperienced investigators, and some bacteriologists distrust even their own results, and change their views after the "test of experience" has been made. But we can detect with certainty the *Bacillus coli communis*, which is a normal inhabitant of the intestines of man and some other animals, and its presence is sufficient to absolutely condemn a water which contains it, in the absence of a system of thorough purification.

Detecting Origin of Pollution.

It is sometimes desirable to determine the origin of pollution of a water-supply. This is done by introducing into the various suspected sources some foreign substance that can be readily detected in the water, and yet will be harmless if taken into the system in small quantity with the water. By comparing the chlorine of city wells before, with the excess found some days after, a large amount of common salt and water has been added to adjacent privy-vaults, serious contamination is often detected. The celebrated case of contamination of the Lausen (Switzerland) water-supply was detected by placing a large amount of common salt in the suspected polluting stream, about a mile distant, on the opposite side of the Stockhalden, after which it appeared in the spring at the base of the mountain that furnished some of the inhabitants of the town with water. Lithium chloride, which is detected spectroscopically in minute traces, is sometimes used for the same purpose, and has given great satisfaction in legal investigations. The use of fluoresceine, which gives a magnificent yellowish-green fluorescence to water, even in the smallest quantity, demonstrated an underground connection between the rivers Danube and Ach; and in the investigation at Duluth, above referred to, sodium fluoresceine placed in a sewer appeared at the end of the intake, at a distance of several hundred feet from the shores of Lake Superior, in four and one-half hours, and remained for forty-two hours, thus showing, in the most satisfactory manner, the sewage contamination of the city water supply. Analine red, analine blue, and in some cases even Prussian blue have given satisfactory results in detecting the origin of pollution. Whenever any of these substances demonstrates a connection between a water-supply and sewers, privy-vaults, or other sources of contamination, the water cannot be used with safety for drinking, except after boiling or sanitary filtration.

AN EFFECTIVE SYSTEM OF FINDING AND KEEPING SHOP-COSTS.

By Henry Roland.

DURING the publication of four papers under the general title of "Cost-Keeping Methods in Machine Shop and Foundry," closed in the January issue of this magazine, letters from several firms were received by the author, asking for a simple and easily-installed cost-keeping system. All of these letters came from long-established, prosperous concerns, widely known in their respective fields, which included what might fairly be called all weights of metal manufactures.

Perhaps an adequate reply to this request for a simple and satisfactory system of shop-cost keeping is an impossibility, but, after careful consideration, it has been decided to give, in the present series of papers, the very simplest cost-keeping system known, which begins and ends with the "job-ticket" alone, as will be fully explained, and to follow this with a recital of the things done recently by some old and highly successful metal-working concerns which are endeavoring to find out what is really done in their own shops.

At first sight it seemed strange that the names of widely-known and highly reputable firms should be signed to these inquiries, which were all substantially the same, saying that the books and accounts kept failed to give information of indisputable accuracy, and that a need was felt for cost figures of absolute reliability, upon which future transactions could be based with the confidence born of certainties as to the history of the past.

But, as one considers the probable history of a long-established business which has grown from the humblest beginnings to a commanding position, it becomes clear that such manufactories are almost certain to rise from the early day of small things to very considerable size without the formulation and inauguration of a system of accurate shop account keeping, and that, when a business has become large, and is paying well, its internal operations are very likely to be continued in the path of least resistance. It is far easier to let a river run on and guess at what really underlies the strong current, than to go resolutely to work and spend the amounts of money and vital force needful to obtain an accurate knowledge of that river's bed.

A business is established, say, in the smallest possible manner, with one master workman of ability at the head of the few others for

whom he can find work. The mind of this master, in most ventures which reach final success, is wholly employed in perfecting his output and the means for its production. His accounts are kept in his head. He knows what his last work cost him, or so nearly that he can make a price for his next delivery ; and that matter does not seem to him of nearly so much importance as how to better his product and increase his sales, which are problems increasing in importance with every step of advancement in public esteem and confidence. Very soon the "leading hand" appears, the right-hand man who has a memory and executive powers which can be exercised under the direction of another, and the "leading hand" becomes the depository of a mass of unrecorded information not possessed by the owner, and which he is glad not to be obliged to know, as this ignorance leaves his mind free for things of more present importance. As the establishment increases, it divides itself into departments, each practically under the exclusive control of some man whose fitness has gained him the post of authority, and so the natural-selection process goes on, the establishment having never been homogeneous since the day its founder first made a favorite workman "leading-hand." As it increases in size, it becomes every day more and more an assemblage of independent powers, operated still, it may be, in thorough harmony to a common end, but on wholly independent lines of management in different departments, and always approaching a point where these independent subordinate managers of either real or recognized authority are secretly or openly jealous of each other, and where each one sees that, the less any one else knows about the actual facts of his department, the better the chances are for his continuance in his position.

This is, I think, the real condition of every old and long-established manufactory which began in a small way, and, when this condition is once reached, the "main office" can ask in vain for detailed information. Only those who have attempted to institute a system of open, accurately-detailed accounts in a factory which has grown from nothing to eminence under the "leading hand" and "head-of-the-department" system of management can understand the obstacles which prevent the gathering and tabulating of such information as would enable the general manager to systematize an established business directed in detail by old employees on their own lines, who fully believe that, if they once tell all they know, others will be as wise themselves and the day of their reign will end forever.

The young and ambitious manager who takes the helm of a successful old firm finds at once that he is not to know the details of the factory of his own knowledge. He is to take his information at sec-

ond hand, or go without it. If he accedes to this, all is smooth, amiable, and prosperous on the surface, and perhaps a very wise young manager under such circumstances may be fully justified in a seeming acceptance of the situation, trusting to time and his own vigilance to gradually increase his knowledge of facts, and finally place him in a position to act with confidence of success. If the other course is taken, and the new manager makes a defined and persistent effort to compile actual shop performances, the result probably will be his removal from authority, as affairs speedily lead to a direct clash between the new man and the old, faithful, and indispensable workers who have, perhaps even from the first day the factory opened its doors, toiled earnestly in its interests, according to their individual lights, and have certainly greatly aided in its prosperity. Between a new manager who wants to know, and a force of old heads of departments who do know and will not tell, the board of directors is often called upon to arbitrate, with the full knowledge that to sustain the manager means no dividends for a year or two years, while to sustain the subordinate chiefs means the perpetuation of the mysteries and tyrannies which are so unendurable to the unfortunate new manager, and which the board of directors would gladly see abolished, but which they have not the courage to assail, in view of the results sure to follow. If self-preservation is the first law of nature, then the directors often cannot, or think they cannot, uproot the old system of management by departmental heads, because the house is not so strong as it looks and is rated to be, and a year or two without dividends would call public attention to matters which cannot safely be placed before the public eye.

If the new manager is intelligent and experienced, he knows that a general disturbance and overturning of shop routine will lead to those immediate losses which are sure to follow the disaffection of the workmen, who always resent a change in shop-methods, although he is perfectly certain that the introduction of a thoroughly organized system of passing work through the shops would surely lead to economies which would far more than repay the inevitable immediate losses, and would place the concern on an even basis with competitors, who always threaten the continuance of prosperity, I think, in a very visible and unmistakable manner, before a new manager is called in by the directors.

I am sure that I am not at all overstating the case of the new manager and of management by departmental heads. Nor do I err in regarding such a situation as always perilous for all concerned. The old employees have a seemingly just cause, based on long and faithful and successful service, than which there is no better certificate

of merit. Yet the concern sees itself undersold, although it has made all possible concessions to retain trade. Besides, the directors and the new manager well know that no house can ever stand still. A business must advance, or must fall back, and to fall back steadily means present extinction.

In this dilemma of the directors, the new manager, and the old heads of departments, all equally eager for the success of the business, and yet so hopelessly antagonized as to the details by which that success shall be reached, what is to be done?

First of all, it is absolutely certain that the old sub-managers, the departmental heads who really direct the internal economy of the concern and control the labor cost of the output, will not of their own motion make work cost less in the future than in the past. Hence in some way work must be traced through the shops, establishing a reliable record as it goes, because comparison of reliable records is the first step toward a reduction of cost of product.

But how?

Evidently best by some means which will avoid any open clash at the outset. Although the simple means here proposed may seem inadequate, and is offered with some diffidence by the writer, it appears that the job-ticket may be made to serve all needful purposes in manufactures of small weight, and perhaps in all metal-working establishments which do not at present know what is being done in their own shops.

The manager can say to any head of a department, no matter how lordly and autocratic a despot he may be: "Mr. Brown, I am truly glad to be associated with a man of your long experience and ability, and I can assure you that not the slightest change will be made in your department without your approval, so long as I can prevent it." And the new manager can make this diplomatic speech with a close approach to certainty that it will place matters on a footing of at least ostensible agreement and harmony as between himself and his subordinate so addressed, and that for a certain time, and perhaps permanently, there will be a plainly-manifested desire on the part of the departmental head for joint consultations over matters of shop policy, and an evident willingness to accede to proposed reforms which will leave him still in control of his original territory. The cordiality of the subordinate may be not altogether sincere, but, as he wishes to retain both his place and his authority, and sees a way opened to keep both, he is almost certain to declare with at least an appearance of hearty alacrity in favor of all possible suggestions of improvement in methods.

This basis of action must be established, unless the general resig-

nations of heads of departments are resolved upon, which is always unjust in a certain sense, and always, without qualification, costly for a time to the manufactory. Having established this platform of mutual action, each department manager should be consulted with the utmost patience in regard to improvements in production; and the importance of tracing work through the establishment generally, and particularly through the important department under his own control, should be enlarged upon, until finally the absolute necessity of a rough-stores room and a finished-stores room is agreed upon. When this point is once reached, all the rest is perfectly easy, and becomes a mere matter of time and course. The rough-stores room and finished-stores room may even be departmental, at first, if needful to smooth action, for any rough-stores and finished-stores room system involves the job-ticket, without which nothing can leave the rough-stores room or enter the finished-stores room, and without which, in light work at least, no workman can draw pay for his work, no matter what system of labor recompense is adopted,—piece, day, or premium pay. It at once begins to furnish the main office with an itemized and perfectly accurate account of all the details of shop method and management which have hitherto been the precious-guarded secrets of the department Autocrat, who, like the gigantic Troll of Scandinavian folk-lore, becomes powerless the moment light reaches him.

The job-ticket is by no means new; it is employed in some form in every system of shop-cost keeping. Nor is it new to rely on the job-ticket alone, as is here proposed. The De La Val shops (all of whose shop-blanks were given in the November (1897) issue of this magazine, beginning on page 230) make the job-ticket (p. 233) cover almost as wide a field as it is here proposed to have it occupy. It is absolutely needful, in order to establish a record of factory operations, that a rough-stores room in charge of a rough-stores keeper, made responsible for all that comes into it and all that leaves it, and a finished-stores room under entire control of a finished-stores keeper, be provided. All work done in the shop must have a starting-place, a way-bill on which the events of its passage through the hands of the workmen can be recorded, and a place of delivery where the finished work, and its history as recorded on the way-bill or job-ticket, are received together. There must be no possibility of anything whatever making its way out of the rough stores room, or through the shops, or into the finished-stores room, without an accompanying job-ticket, there must be no possibility of a halt by the way without a record of the delay on the job-ticket; and no labor can be paid except from credits entered on the job-ticket. When

these conditions are filled, the flat-cost or stock-and-labor-cost come at once into the possession of main office.

And, if a percentage of expense, based on the "number of hands in work," be established, total costs can be at any time computed from the job-ticket footings by one multiplication. Perhaps no better or more thoroughly practical system of estimating the percentage to be added to prime-cost to give total-cost can be devised than that based on the number of hands in productive work. If this be accepted, then the number of hands in work, stamped on the job ticket for each day of its passage through the shop, gives the correct average percentage to be added to prime cost to give total cost of the complete job.

Like all other general rules, this "hands in work" percentage would find an exception in unusual occurrences, as in the case of very few men working on a non-legal holiday. But for all purposes of average accuracy, which is all that can be obtained by any system of total-cost estimating, the number of hands in work seems to be nearest to a correct deciding factor.

While the rough-stores room and finished-stores rooms are here spoken of as necessities of successful manufacturing, it is, of course, to be understood that, at some point of ponderability, transportation of pieces under construction for the mere purpose of safe keeping becomes impracticable; and, when work comes to such weight that its handling forms an important feature, the establishment becomes a "shop" instead of a "factory," and both the rough-stores room and the finished stores room disappear. The exact weight of single pieces at which the manufactory changes to the shop has not been determined. The Reed lathes are made on manufactory lines, and all farm-machinery, including traction-engines, can start from the rough-stores room and end in the finished-stores room. But, while the job ticket is an indispensable adjunct to the rough-stores and finished-stores rooms, it can exist independently of them, and the first form given is that of a job-ticket adapted to machine-work of the heavier class, where the pieces undergo different operations at the hands of different workmen and occupy considerable time in finishing. The job ticket for heavy shop work is a more complicated affair than that for single operations on small pieces, of which hundreds or thousands may be handled in a day by one hand; nevertheless, it seems perfectly competent to fully record all the important items of the shop history of the heaviest pieces.

It is true that common experience indicates the propriety of demanding as little as possible from the workman in the way of clerical labor, but it is the rule, I think, to use the workman's time-slip, on

which he enters his time for each day, in charges against the job or jobs on which he may be employed ; the same time slip serves to distinguish common time from over-time, since the two are usually paid different hour-rates to the same individuals.

If the workman can correctly record his time on one slip of paper, he can do so on any, and there is no apparent reason why two or more workmen should not record their time on the same job-ticket, provided with a sufficiency of individual spaces of time-entry.

This makes the collective job-ticket appear possible, though it may prove in practice one of those labor-savers which are successful in some hands and failures in others.

The advantage of the collective job-ticket is that a single ticket may be made to give the entire labor-cost of an elaborate construction, in the production of which many hands have been used, while the simple single-day time-slips are unavailable as a source of information as to total labor costs until after they have been through the hands of the cost-clerk, who extends, collects, and tabulates the mere hour-charges recorded.

To meet all the contingencies, an example has been taken from actual practice in the finishing of a Corliss cylinder, 28 inches by 60, which was a "hurry" job, and was pushed day and night, requiring over time, and this under a shop system which charged the time of helpers to individual pieces of work. A simpler method is to charge the helper-time to the expense account in a lump.

If the pay roll is made up from the time-slip or job-ticket, collective or otherwise, then the collective job-ticket must be out of the shop and in the hands of the paymaster's department for at least part of a day in each week.

It is, however, in most cases far better, in heavy shops, to make up the pay-roll from individual workmen's brass checks, consecutively numbered. A workman, on leaving the shop, takes his check from a hook on a board in the porter's office, and deposits the same in the check box as he next enters the works. By this system the pay-roll time can be checked up within an hour after starting-time each half-day, so that payments on Saturday up to Saturday night are made possible, if desired. Usually payment is to Friday night, if made on Saturday, and, with the brass time-check system, the job-ticket has nothing to do with the pay-roll, and can remain in the shop until the job is completed.

In addition to the individual brass time-check, this writing supposes each department of the shop to be furnished with the well-known self-dating clock-operated stamp, by which the correct time stamp may be affixed to each job ticket as often as needed, with per-

Order 2017. Machine 34. Drawing March 10, '94.

430 (Hands in work).

February 7, 1898, 2 30 A. M. John Smith, Job Master.

I have all material in hand.

John Brown, Foreman.

Foreman's clock
date, Feb. 7, '98.
10 A. M.

Operation Finished.

Date given to workmen. (Clock Stamp)	Workman's Name.	No. Tool.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.	Thurs.	Fri.	Sat.
Feb. 7, '98. 10 30 A. M.	A. Smith.....	Overtime. 5		5	10	10														
Feb. 7, '98. 10 30 A. M.	B. Smith (helper).....	Overtime. H		5	10	10														
Feb. 7, '98. 10 30 A. M.	C. Smith.....	Overtime. 5		10	10	7														
Feb. 7, '98. 10 30 A. M.	D. Smith.....	Overtime. H		10	6½															
Feb. 10, '98. 7 00 A. M.	E. Smith.....	Overtime. 7					10	10	10	6½										
Feb. 14, '98. 7 00 A. M.	F. Smith.....	Overtime. H					10	10	10	6½										
(Fold here) Feb. 14, '98. 7 00 A. M.	G. Smith (Fitter).....	Overtime. F		5	5	5														
Feb. 14, '98. 7 00 A. M.	H. Smith.....	Overtime. F		10	10	10	10	9½												
Feb. 14, '98. 7 00 A. M.	I. Smith.....	Overtime. H		10	10	10	10	5												
Feb. 14, '98. 7 00 A. M.	K. Smith.....	Overtime. F		10	10	10	10	7												
Feb. 14, '98. 7 00 A. M.	L. Smith.....	Overtime. F		10	8	10	10	10												
Feb. 16, '98. 9 00 A. M.	M. Smith.....	Overtime. F					8	3												

Feb. 21, '98.
10 30 A. M.

John Smith, Job Master.

Total Hours Labor, - - - 422
Total Labor Cost, - - - \$162.00.

fect accuracy and the least possible labor. No system of shop records should be favored which reduces the responsibilities of the foreman, but the foreman's labor should be reduced by all possible methods.

A sample form of the job ticket is illustrated on the opposite page, perhaps more extensive than will often be necessary.

The job-ticket must originate with the order department, of course, and will henceforward be supposed to be issued, directly, by the "job-master," and by him transferred to the foreman who is to have charge of the work.

The job-master's self-dating clock prints the date and also the number of hands in work, which is changed as occasion requires, so that the expense percentage to be added to the labor-costs recorded on the card is defined.

The first item of the first dated line of the card is the number of men in work and the date,—hour and minute,—followed by the job-master's own stamp. Since this date is printed from the clock-stamp, it fixes beyond question the hour on which the job-ticket was made. The same line continues with a statement that the foreman has all needed stock for the job in hand, and is followed by the foreman's stamp and, at the end of the line, a foreman's clock-stamp date, which fixes the time at which the order was accepted by the foreman from the job-master.

The remainder of the card is filled with spaces for two weeks' work of each of twelve individual workmen, with date spaces at the left, which the foreman fills with clock-stamp dates, as he delivers the job-ticket in succession to the hands who are to work upon it, and a similar date space at the right, which is filled as the job-ticket is returned to the foreman at the completion of each stage of the work.

By this collective job-ticket, as shown in the illustration, the entire labor-cost of boring, milling, drilling, tapping, and fitting this 28x60 Corliss cylinder is given as 422 hours. The machinist's time and laborer's time are given in separate items, with the over-time and common time distinguished from each other. The tools used are specified by their shop numbers. The machine number and detail-drawing date are given, all dates are recorded, the expense percentage is fixed, and, with the least possible labor of the cost-clerk, the aggregates and the total cost can be obtained, and, without any additional book-keeping, the job-ticket furnishes a complete shop-history of the job, and can be filed, card-index fashion, as a completed record.

This case of the Corliss cylinder may be regarded as extreme in respect of number of separate entries; perhaps less than twelve workmen's names on one card would be better. Two cards with six names each could be used; still, if the job-ticket is to be used at all in the

collective form, it should be used in such amplitude as will enable all details of each single job to be recorded on the one ticket.

The great advantage of the collective job-ticket lies in the immediate availability of its record. With the single-man, single-day time-slip, aggregate information is to be had only after all the single time-slip entries have been combined in a new statement, involving clerical labor, the possibility of clerical error, and an added document to be verified only from the original time-slips, at considerable expenditure of time and labor.

These advantages of the collective job-ticket seem to entitle it to careful consideration for heavy work regarded as insusceptible to factory methods.

For less complicated operations, where each job-ticket covers a single operation, as the job-ticket is commonly used, the collective form seems to have the same advantages, as will be shown subsequently, although it has not, so far as known, been used in the collective form in actual practice.

NOTABLE SPEED-TRIALS OF BRITISH LOCOMOTIVES.

By Charles Rous-Marten.

IT is extraordinarily difficult to find out accurately how fast a British locomotive can run.

As a rule, the railway companies and the locomotive engineers seem greatly to prefer that the public should know nothing about it. Even for official information as to locomotive capabilities, really exhaustive tests are rarely made. When it is ascertained that an engine can do the duty required, that is sufficient. The British companies do not desire increased speed; they think it means enhanced expense; they doubt whether the public like it; they are readily influenced by the ignorant clamour about "excessive and dangerous speeds" which some foolish, or cowardly, or obsolete, persons so frequently raise without the slightest grounds.

No sense of patriotism inspires British railway officials with a resolution to break a foreign record. Quite the contrary. The establishment of a new record by America, for instance, merely elicits a smile of complacent gratification that expense is not incurred for such purposes in England. "Railways," say the British authorities, "are purely commercial undertakings, carried on for money-making purposes, and not for record-breaking, or racing, or anything of that sort." If a competing line goes ahead, that has to be matched; but the patriotic anxiety with which railway records are striven for in America is unknown in Great Britain, so far as the railway companies themselves are concerned. And so any display of exceptional velocity is, as a rule, discouraged. It is only now and then, when a novel type of locomotive comes out, that permission can be obtained to "let her out" and "show her paces."

One such occasion has occurred lately, and the outcome has been the breaking of all previous British records for maximum speed.

Before describing this interesting experiment, I will review briefly the previous records in British practice. It is greatly to be regretted that so many notes of speed-performances which would have been most valuable, if manifestly trustworthy, have been vitiated by obvious carelessness or error. This applies to both sides of the Atlantic. Where timings for short distances are given only to the even minute, where station-distances over a whole journey are given only to the even mile,—no other distances being supplied—and where the times

of adjacent distances are palpably inconsistent with the "record" length put forward,—it is impossible to accept them as authentic for scientific purposes. For, as results, one sees a speed of 87 miles an hour claimed for one length, when the two adjacent lengths—that preceding and that following—show rates of only 55 or 60 miles an hour; when a distance of 2.8 miles is claimed to have been done in "2 minutes," whereas the "log" shows the time to have been $2\frac{1}{2}$ minutes; when a second station is shown as having been passed half a minute before the previous station was passed; and when a train is represented as coming to a stand 1 minute after passing a point 1.7 mile distant. Such things have come under my personal notice, in Great Britain and America alike.

One of the earliest speed-trials made with engines used in modern times was that conducted by Mr. Brunel, Mr. (afterward Sir Daniel) Gooch, and Mr. Charles Sacré (subsequently engineer-in-chief to what is now the Great Central Railway), on the Great Western line, early in 1848,—just fifty years ago. In 1884 Mr. Sacré, then the sole survivor of that eminent engineering trio, placed at my disposal his notes taken on the occasion in question. They proved that on Brunel's famous 7-foot gauge, three different engines of Gooch's equally famous class of 8-foot single-wheelers—"Iron Duke," "Great Britain," and "Courier"—failed to reach a higher speed than 78.2 miles an hour, when specially tried at their utmost power down falling gradients of 1 in 100. A mile in 46 seconds was their best possible. Yet it has been a long-received myth that these engines often ran at 80, 90, and even 100 miles an hour! The same engines ran until May, 1892, when the 7-foot gauge was abolished, and I made many trips with them, but only on two occasions did they equal the speed of 1848, although having the advantage of higher steam pressure.

It is alleged that Trevithick's London and North Western engine "Cornwall" (built in 1847, with the boiler below the axle, and still running as a locomotive of the ordinary type, though retaining her $8\frac{1}{2}$ -foot single driving-wheels), and McConnell's $7\frac{1}{2}$ -foot single-wheeler, No. 373, each attained, on the gauge of 4 feet $8\frac{1}{2}$ inches, a speed of more than 79 miles an hour in special trials; but the methods seem to have been of the "rough and ready" order, and no adequate records have been left.

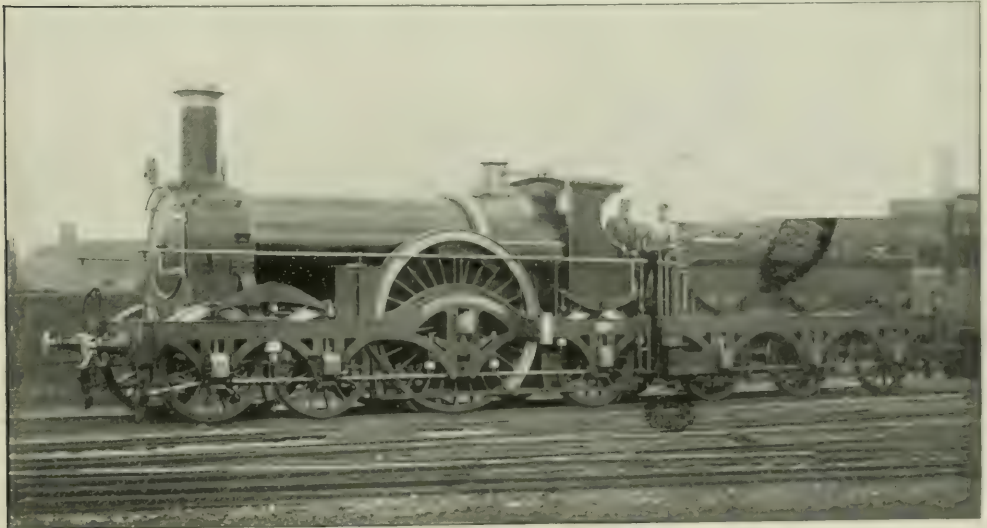
Then, in 1853, the 7-foot gauge again came to the front. One of Mr. Pearson's ten-wheeled double-bogie tank engines on the Bristol and Exeter line, having single-drivers 9 feet in diameter, attained in two special trials, down the Wellington incline of 1 in 81, speeds of 80.0 and 81.8 miles an hour respectively. At a later period these locomotives were rebuilt, with 8-foot single-drivers; testing one of



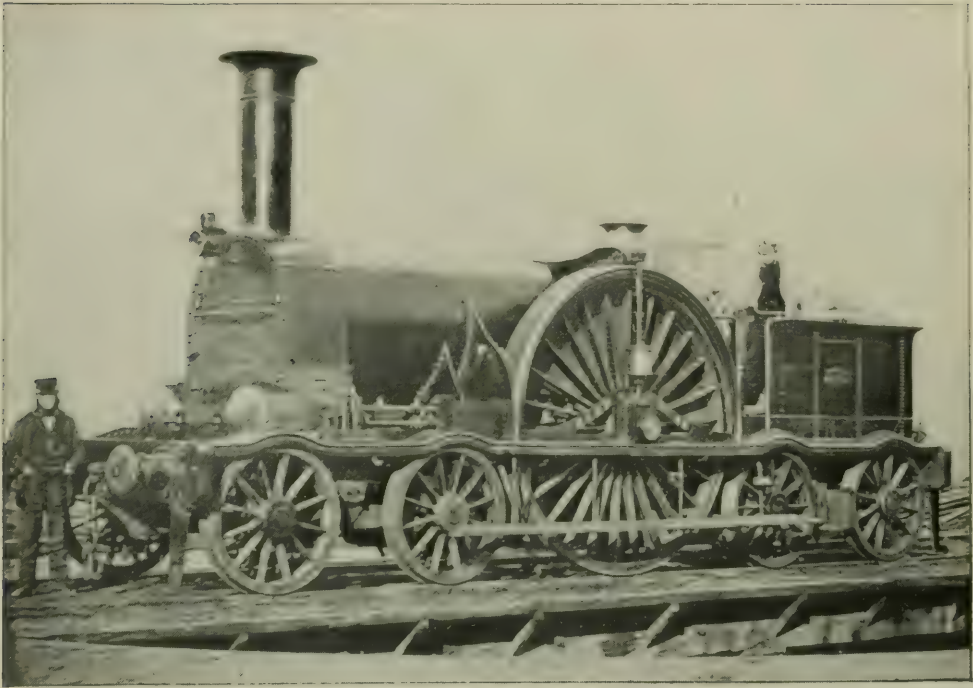
LONDON AND NORTH WESTERN "CORNWALL," NO. 3020. BUILT 1847.
Cylinders $17\frac{1}{2} \times 24$; driving wheels 8 ft. 6 in.; by J. Trevithick. Originally had the boiler below the axle, and was rebuilt as shown by Mr. J. Ramsbottom. It was in the exhibition of 1851, and is still at work.

them down the same incline a few years before the 7-foot gauge ceased to exist, I also obtained a rate of 81.8 miles an hour.

For many years after 1853, however, that rate of a mile in 44



GREAT WESTERN "PROMETHEUS," 7-FOOT GAUGE.
Cylinders 18×24 ; driving wheels 8 ft.; by D. Gooch.



BRISTOL AND EXETER NO. 44; ORIGINAL FORM.
Cylinders $16\frac{1}{2} \times 24$; driving wheels 9 ft.; by J. Pearson.

seconds remained an absolute "record." Nor is there absolute certainty as to the time when that record was first broken. In 1870 the late Mr. Patrick Stirling brought out on the Great Northern Railway



BRISTOL AND EXETER NO. 2001. SAME CLASS AS NO. 44, REBUILT, WITH TENDER AND WITH 8-FOOT DRIVING WHEELS.

Cylinders 18×24 ; driving wheels 8 ft.; by J. Pearson.

the first of those splendid 8-foot "singles" which have since won world wide celebrity. Phenomenal velocity was soon claimed for these new-comers, but no authentic accounts exist of any speed exceeding 75 miles an hour during their earlier days. Their author reported a trial run of 15 miles in 12 minutes with sixteen coaches, but the time was admittedly taken in very loose fashion, and, on an attempt being made to repeat the performance, it proved impracticable with such a load. But, with new boilers, increased steam-pressure, and cylinders enlarged by boring out, these engines improved upon this maximum. Testing one down a long bank of 1 in 200, in 1893, I obtained a speed of 80 miles an hour. The driver maintained that this was the best it could do. However, on giving it another notch, 81.8 was reached. But an additional notch brought the rate down to 78,



GREAT NORTHERN RAILWAY NO. 1008.

Cylinders 19x28; driving wheels 8 ft. 1 in.; the other five in this class have 19½ in. cylinders; by P. Stirling.

owing to back pressure in the cylinders, the engine being unable to exhaust with sufficient rapidity. Later, by different management, I obtained a speed of 83.7 with one of these engines down 1 in 200, and I am convinced that down a steeper grade still faster travelling could be done. But the Great Northern line does not afford any great length of grades steeper than 1 in 200, and so the trial has not taken place. The unique length of these engines' piston-stroke,—28 inches,—while enhancing their pulling power, is possibly disadvantageous as regards the attainment of extreme speeds.

On this ground, in fact, they have been beaten by Mr. Stirling's other class of single-wheelers, those with drivers 7 feet 7 inches and

inside cylinders $18\frac{1}{2} \times 26$. With these I made several special speed-trials with interesting results. One which had cylinders bored out to $18\frac{7}{8}$ inches attained successively 81.8, 82, 83.7, and finally 84.1 miles an hour, the fastest mile being done in 42.8 seconds. This occurred on two different occasions. I was not satisfied that the *maximum possible* had been reached, but the driver was nervous about attempting any more, and so the record rested there for awhile. It was promptly equalled, however, by three different Midland engines of virtually identical dimensions, but possessing what I deem the material advantage of leading bogies in lieu of the radial axles under the leading end of the Great Northern inside-cylinder single-wheelers. Also one of Mr. W. Dean's "singles," 7 feet 8 inches, used for express work on the Great Western since its conversion to the gauge of



GREAT NORTHERN RAILWAY NO. 235.

Cylinders $18\frac{1}{2} \times 26$; driving wheels 7 ft. 7 in.; by P. Stirling.

4 feet $8\frac{1}{2}$ inches, ran them very close with a maximum of 83.3 miles an hour. Meanwhile various classes of coupled engines on several railways had come markedly to the front, and, alike on the London and South Western, London and North Western, Midland, and Caledonian lines, had run at speeds of 85 to 82 miles an hour. And now several classes of coupled engines pushed forward into the front place of all. During and after the famous "Race to Aberdeen" of 1895, I had the opportunity of testing coupled locomotives on the London and North Western, North Eastern, and Caledonian Railways respectively, at speeds ranging as high as 85.7 miles an hour, or a mile in 42 seconds. The three classes which had reached this point differed in a remarkable degree. The London and North-Western engine was by far the smallest, having cylinders only 17 $\times$ 24, with coupled



MIDLAND RAILWAY NO. 1865.

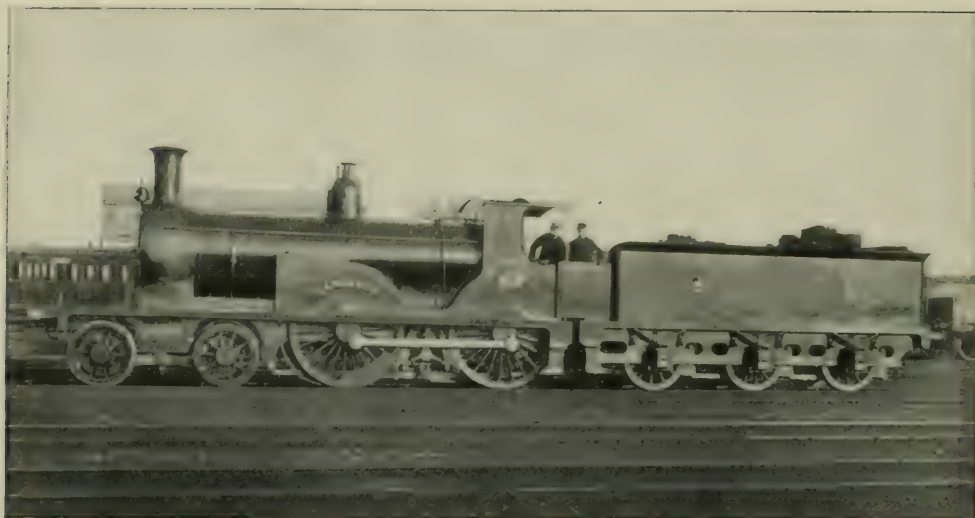
Cylinders $18\frac{1}{2} \times 26$; driving wheels 7 ft. 6 in.; by S. W. Johnson.

wheels 6 feet 6 inches and weighing only 32.7 tons. The Caledonian engine had cylinders 18×26 and coupled wheels 6 feet 6 inches, and weighed 47 tons. The North Eastern locomotive had cylinders 19×26 , and 7-ft. coupled wheels, and weighed 51 tons. Yet each managed to break all the past records of the single-wheelers.



LONDON AND NORTH WESTERN "CHARLES DICKENS."

Cylinders 17×24 ; driving wheels 6 ft. 6 in.; by F. W. Webb.



CALEDONIAN RAILWAY NO. 79.

Cylinders 18×26 ; driving wheels 6 ft. 6 in.; by D. Drummond.

So did one of Mr. F. W. Webb's 3-cylinder compounds on the London and North Western, with high-pressure cylinders 15×24 , low-pressure cylinders 30×24 , and four 7-foot single drivers; so also did Mr. Worsdell's single-wheel two-cylinder-compounds with 20-inch high-pressure cylinders, 28-inch low-pressure cylinders, and wheels 7 feet 7 inches. Each of these succeeded in covering the mile in 42 seconds = 85.7 miles an hour. Then, in 1896, Mr. J. F. M'Intosh's splendid "Dunalastair" engines on the Caledonian line, with cylinders $18\frac{1}{4} \times 26$, coupled wheels 6 feet 6 inches, and vast boiler power, "tied" the record of 85.7 in several special trials which I was able to make. Even at that high point they were not working to the limit of their capacity, but necessities of traffic-working prevented me from pushing them to their utmost.



NORTH EASTERN NO. 1038.

Cylinders 18×26 ; driving wheels 7 ft. 7 in.; by W. Worsdell.



NORTH EASTERN NO. 1517; COMPOUND.
Cylinders 20 and 28 by 24; driving wheels 7 ft. 7 in.; by T. W. Worsdell.

Toward the end of 1896 I made another trial of one of the Great Northern inside-cylinder single-wheelers, 7 feet 7 inches, down a long bank of 1 in 178, 1 in 200, and 1 in 264. This particular engine had 18 $\frac{3}{4}$ -inch cylinders. The previous record by this class was steadily overhauled at each mile, and then was passed, a mile being run in 41.8 seconds, or at the rate of 86.1 miles an hour, while three successive quarter-miles were done in 10.4 seconds each, repre-



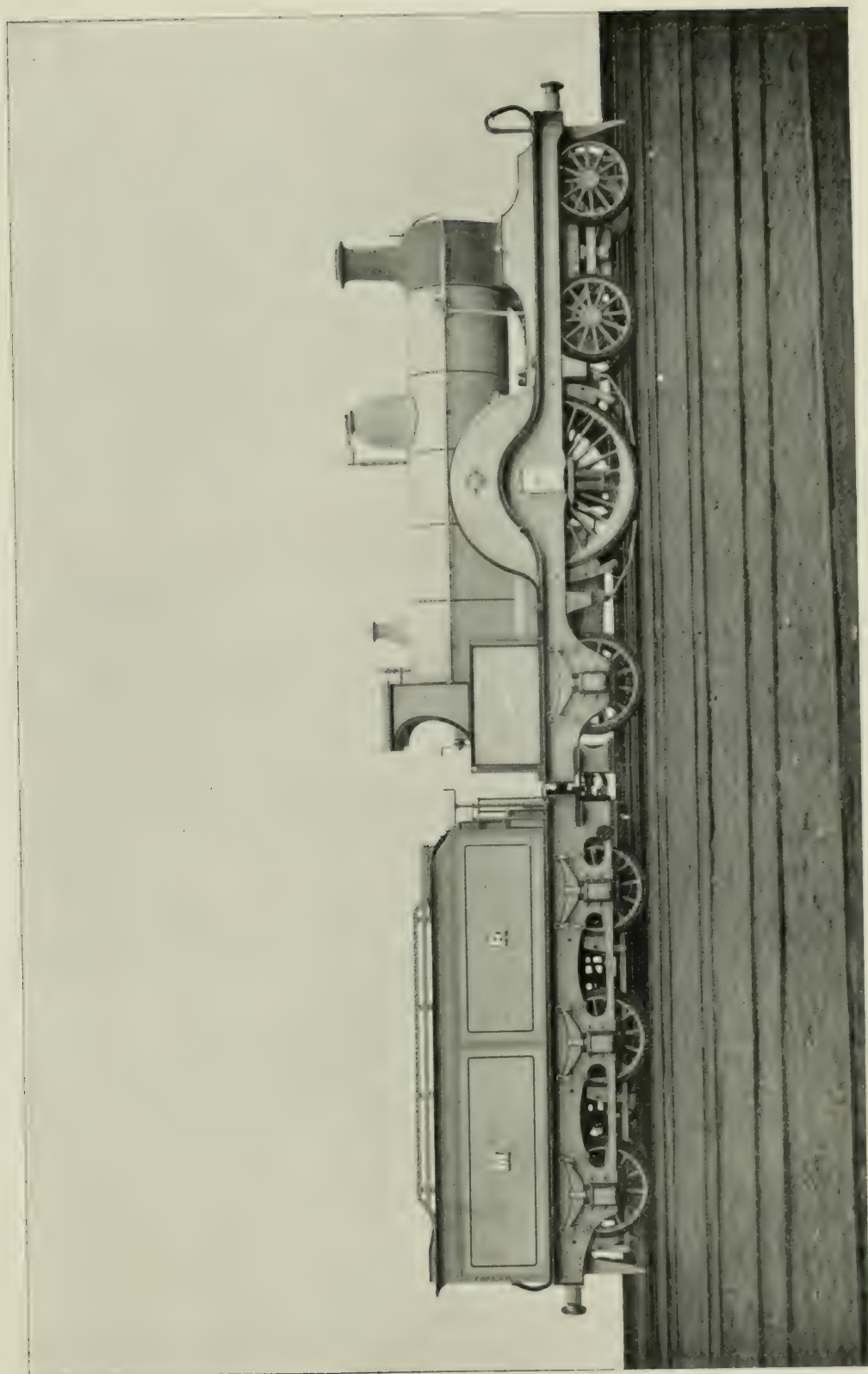
CALEDONIAN RAILWAY "DUNALASTAIR," NO. 721.
Cylinders 18 $\frac{1}{4}$ x 26; driving wheels 6 ft. 6 in.; by J. F. M'Intosh.

senting a speed of 86.5 miles an hour. I do not think the limit had been reached, but most vexatiously an adverse signal compelled a slackening to 10 miles an hour, and the way lost could not be recovered.

In the autumn of 1897, however, when making special observations with a London and North Western train drawn by two of the coupled engines 6 feet 6 inches already mentioned, descending a grade of 1 in 132, two miles were done in 41 seconds each, or at the rate of 87.9 miles an hour; and the next day one of the same engines, running down 1 in 147, following a 4-mile descent at 1 in 75, did a mile in 40.8 seconds, equal to 88.2 miles an hour.

But Queen Victoria's diamond jubilee year was not to close without a still more notable advance in speed. Mr. S. W. Johnson brought out on the Midland Railway five new single-wheel express engines of singularly fine proportions and handsome appearance. They have inside cylinders $19\frac{1}{2} \times 26$, 170 pounds' steam pressure, and single-drivers no less than 7 feet 9 inches in diameter,—the largest wheels ever employed with inside cylinders on a gauge of 4 feet $8\frac{1}{2}$ inches. With these superb locomotives I made several special speed-trials without breaking the record. But finally, testing one of these engines with a load of 150 tons down a long grade, 16 miles, mostly at 1 in 200, I obtained the following remarkable figures for five successive quarter-miles: 10.2 seconds, 10 seconds, 10 seconds, 10 seconds, 10.2 seconds. Thus the engine ran for $\frac{3}{4}$ mile at the rate of exactly 90 miles an hour, the speed for the whole mile being 89.5. Unfortunately, after the third quarter-mile, which was done in 10 seconds, a rising gradient was encountered, which steadily lowered the rate. Had the falling grade continued a little longer, or had it been somewhat steeper, I see no reason to doubt that even a slightly higher velocity might have been reached, as the engine was not only steaming freely, but exhausting her waste steam well, when the highest point was reached. A speed of 80 miles an hour and upward was maintained for 13 consecutive miles. The travelling was admirable in its smoothness and absence of oscillation.

It may be of interest to explain the method that I always employ in testing speeds. While mechanical speed-indicators, such as the Boyer, Westinghouse, etc., may doubtless work well in favourable circumstances, they require special attachment and fitting. It is preferable, therefore, to perfect a system which can be applied to any engine and train, provided that mileposts or distance-points can be recognised. My method is to use three excellent chronographs—one with the split seconds movement—and a watch. At each quarter-mile-post one instrument is started, and another simultaneously stopped. At the end of each mile the split-seconds-hand is split,



A JUBILEE YEAR RECORD-MAKER. MIDLAND RAILWAY NO. 116.
(Cylinders $19\frac{1}{2} \times 26$; driving wheels 7 ft. 9 in.; by S. W. Johnson.

and, at the end of the total length selected for the trial, the chronograph also is stopped, and the times of passing stations, signal-boxes, etc., are noted by the watch. Each observation is at once noted down, either by myself in a note-book open and in readiness, or by a shorthand assistant to whom it is orally dictated. In this way the disturbing element of personal equation is virtually eliminated, and a thoroughly effective triple check is secured. No less elaborate method can be regarded as entirely trustworthy.

This article would be incomplete without some reference to certain noble trials of speed which have taken place between rival companies. Most prominent among these were the celebrated "races" between the East and West Coast routes, from London to Edinburgh and Aberdeen respectively, which occurred in 1888 and 1895.

Viewed in the light of the experiences of 1895, the "race" of 1888 now seems a very mild affair, every record made in the former year having been beaten in the latter. Still, at the time, the performances of 1888 were remarkable as transcending anything previously accomplished, and even to this day they possess some interest. Briefly, the race from London to Edinburgh in 1888 was won decisively by the East Coast—that is to say, by the Great Northern, North Eastern, and North British companies, their best time for the 393 miles to Edinburgh being 7 hours 27 minutes, including a 20 minutes' stop for lunch. The best authentic times for the various stages of the journey were :

STAGES	Distance.	Time occupied.
London-Grantham.....	105½ miles	1 hr. 46 min.
Grantham-York.....	80¾ "	1 hr. 28 min.
York-Newcastle.....	80½ "	1 hr. 21 min.
Newcastle-Edinburgh.....	124½ "	2 hrs. 6 min.

Curiously enough, not one of these best intermediate times seems to have been made on the day when the best complete journey was accomplished.

On the West Coast the journey of 401 miles was done,—by the London and North Western and Caledonian respectively, in 7 hours 38 minutes. The best intermediates, of which only one—the first—was done on the best "through" day, were as follows :

STAGES.	Distance.	Time occupied.
London-Crewe.....	158 miles	2 hrs. 46 min.
Crewe-Preston.....	51 "	0 " 50 min.
Preston-Carlisle.....	90¼ "	1 hr. 30 min.
Carlisle-Edinburgh.....	100¼ "	1 hr. 42½ min.

The engines used were as follows : East Coast, London to York, Great Northern single-wheelers (1) with driving-wheels 8 feet 1 inch in diameter and outside cylinders 18×28, or (2) with driving-

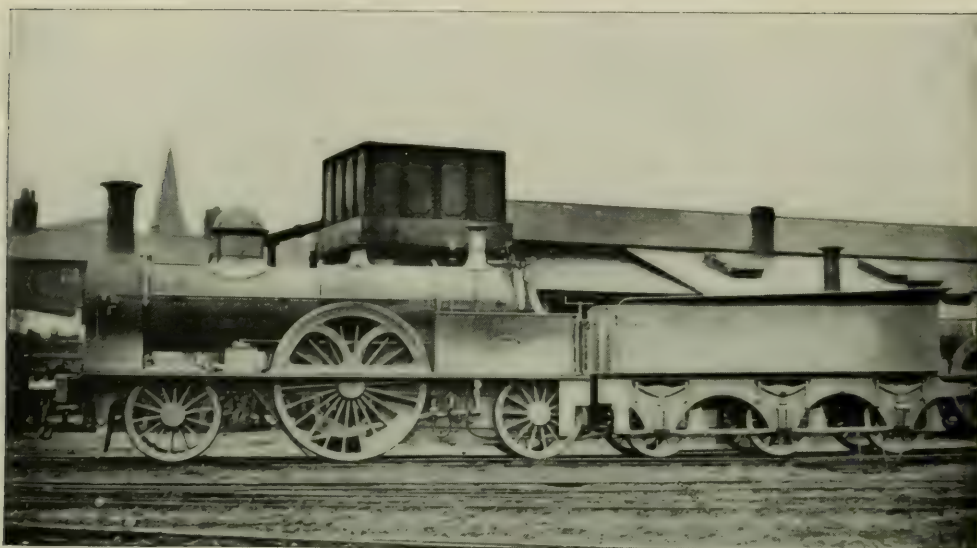


MIDLAND RAILWAY NO. 1757, WHICH RAN 81.8 MILES AN HOUR
Cylinders 18x26; driving wheels 7 ft.; by S. W. Johnson.

wheels 7 feet 7 inches in diameter and inside cylinders $18\frac{1}{2} \times 26$. York to Edinburgh, North Eastern coupled engines, either non-compound with 7-foot drivers and cylinders 18×24 , or compound (Worsdell-Von Borries') with wheels 6 feet 8 inches and cylinders 18 and 26×24 . West Coast, London-Crewe, London and North Western, singles 7 feet 6 inches, outside cylinders 16×24 ; Crewe-Carlisle, coupled 6 feet 6 inches, cylinders 17×24 ; Carlisle-Edinburgh, Caledonian, 7-foot single, inside cylinders 18×26 . The maximum speed attained on each route was estimated as 76.5 miles an hour.

As to the still more remarkable "Race to Aberdeen" in 1895, little need be said, as its marvels are fresh in the public memory, and are frequently revived in controversies as to rival "records."

Briefly, the victory in this case went to the West Coast route, over which the longer journey of 540 miles from London to Aberdeen was accomplished with a light train of 70 tons in 8 hours 32 minutes, or at the average rate of 63.2 miles an hour, including all stoppages, or 64.3, excluding stops. It is only fair to remember, however, that the East Coast did not compete on this final night, having elected to rest on the laurels won the night before, when the shorter distance of 523 miles was done in 8 hours 40 minutes, beating the West Coast on that occasion by 15 minutes. It is interesting to note, moreover, that, on the last three nights of this historical competition, the East Coast journey from London to Edinburgh was performed in 6 hours 44 minutes, 6 hours 41 minutes, and 6 hours 19 minutes, as compared with 7 hours 27 minutes,—the best of 1888. In the earlier in-



LONDON AND NORTH WESTERN NO. 373; IN THE EXHIBITION OF 1862, "EXTRA LARGE BLOOMER CLASS."

Cylinders 18x24; driving wheels 7 ft. 6 in.; by M'Connell.

stance, however, there was an extra delay of 15 minutes for lunch. Still, an allowance made for this handicap, the record of 1895 beat that of 1888 by 53 minutes,—a notable advance.

All but one of the quickest stage times were made on the best night by each route. They were as follows:

	WEST COAST.			Speed.
STAGE.	Distance.		Time occupied.	(Miles an hour)
London-Crewe.....	158	miles	2 hrs. 27½ min.	64.3
Crewe-Carlisle.....	141¼	"	2 " 6 "	67.2
Carlisle-Stirling.....	117¾	"	1 " 53 "	62.5
Stirling-Perth.....	33	"	0 " 33 "	60.0
Perth-Aberdeen.....	90	"	1 " 20½ "	66.7

On the "record" night, the run of 150 ¾ miles from Carlisle to Perth was made without a stop, but at a slower speed,—*viz.*, 60.5 miles an hour.

EAST COAST.				Speed. (Miles an hour)
STAGE.	Distance.	Time occupied.		
London-Grantham.....	105½ miles	1 hr.	42 min.	61.9
Grantham-York.....	80¼ "	1 "	16 "	65.3
York-Newcastle.....	80½ "	1 "	18½ "	61.5
Newcastle-Edinburgh.....	124½ "	1 "	54 "	65.5
Edinburgh-Dundee.....	59¼ "	1 "	0 "	59.2
Dundee-Aberdeen.....	71¼ "	1 "	17 "	55.6

The York-Newcastle run on the best night was equalled on one other occasion, if not twice, during the same month.

On the West Coast the engines used were: London and North Western, Mr. Webb's 7-foot compounds (cylinders 14 and 30 × 24)

to Crewe, and his coupled 6 feet 6 inches (cylinders 17×24) thence to Carlisle; Caledonian, Mr. Drummond's or Mr. Lambie's coupled 6 feet 6 inches (cylinders 18×26) from Carlisle to Aberdeen.

On the East Coast, the Great Northern employed Mr. Stirling's singles 8 feet 1 inch (cylinders $18\frac{1}{2} \times 28$) to York; the North Eastern, Mr. Worsdell's coupled 7 feet 1 inch (cylinders 19×26) York to Edinburgh; the North British, Mr. Holmes's coupled 6 feet 6 inches (cylinders 18×26) Edinburgh to Aberdeen.

Maximum speeds of 85.7 miles an hour were attained on the West Coast by the London and North Western and Caledonian coupled 6 feet 6 inches, and on the East Coast by the North Eastern 7-foot coupled. The other engines, however, do not appear to have been pressed to their utmost capacity.

Early in 1897 a curious series of speed trials took place. The proceeding was virtually forced on the North British Railway, a line not usually distinguished for exceptional speed, by the culmination of its long-standing dispute with the North Eastern company as to the working of the line from Berwick to Edinburgh. This length of $57\frac{1}{2}$ miles had been worked, up to that date, by the North Eastern engines, so far as the through Anglo-Scottish expresses were concerned, owing to considerations of convenience, the North British paying for the service of the engines. But, under new management, the North British, desiring to terminate this arrangement, gave notice to the North Eastern that, at the expiration of January, 1897, of the old agreement, it would not be renewed on the same terms, but that the



LONDON AND NORTH WESTERN "TEUTONIC," NO. 1301.

Compound, cylinders 14 and 30x24; driving wheels 7 ft. 1 in.; by F. W. Webb.

North British company would work all the through trains on its own line. The North Eastern authorities contended that, having statutory running powers as far as Edinburgh, they had a right to insist on continuing to work the trains.

The rights of the case are still under litigation, being now before the *eighth* court that has adjudicated on the matter. But the North British authorities positively declared that they would not permit the North Eastern engines to work the through expresses after the expiration of the old agreement, and arrangements were made for changing locomotives at Berwick.

Now, this was a simple enough matter as regarded the expresses which stopped regularly at Berwick, such as the "Flying Scotchman" and the "Corridor Diner." The time allowed was ample for the change. But two of the night expresses "down," and one "up," were timed to run past Berwick without stopping, the former making the long run from Newcastle to Edinburgh, 124½ miles, in 2 hours 23 minutes, or at the average rate of 52.2 miles an hour. It was contended by the North Eastern company that this could not be done over a somewhat heavy road, if the trains were delayed at Berwick. The North British authorities replied that it could and should and would be done. They pledged themselves that no time should be lost by *their* engines, but that, if "the North Eastern engines delivered the train punctually at Berwick, the North British engine should ensure its punctual arrival at Edinburgh." And so a "match against time" was virtually entered upon.



LONDON AND SOUTH WESTERN NO. 686.
Cylinders 19x26; driving wheels 7 ft. 1 in.; by W. Adams.



NORTH BRITISH RAILWAY NO. 634.

Cylinders 18x26; driving wheels 6 ft. 6 in.; by M. Holmes.

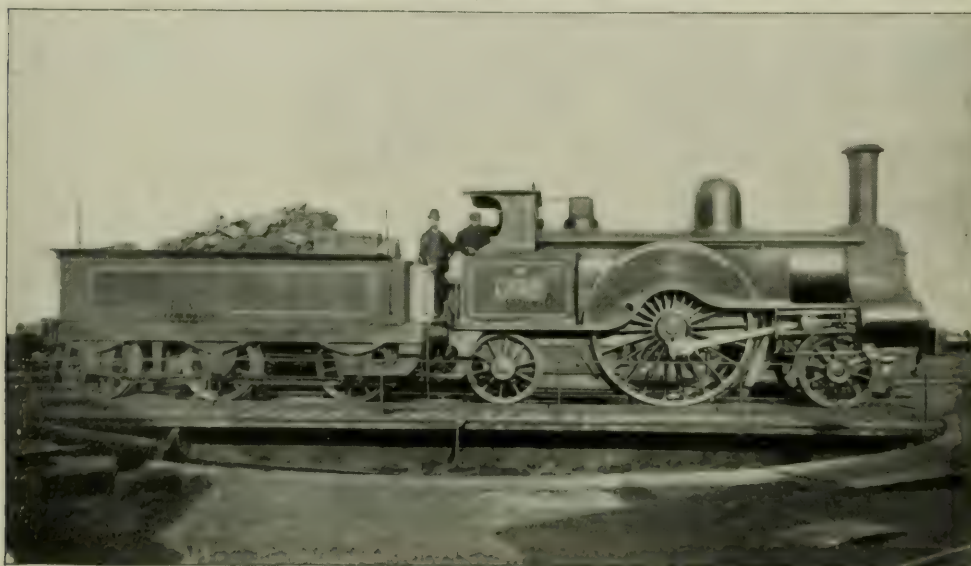
The task set was to run the $57\frac{1}{2}$ miles from start to stop in 63 minutes, about half the distance being up-hill. The journey began with a climb to Grant's House Summit, 17 miles, mostly at 1 in 190 and 1 in 200, with a short break about midway. Then came a 5-mile drop at 1 in 96, then an easier descent of 6 miles to Dunbar, followed by short alternate rises and falls, and concluding with a steep rise of 1 in 78 into Edinburgh.

Although it was found by experiment that one of Mr. Holmes's coupled engines 6 feet 6 inches (cylinders 18×26) could easily keep time,—one, indeed, running the heavier opposite journey, with 220 tons, in a minute less time,—as the company was upon honour to maintain absolute punctuality, an assistant engine was always used on these particular trains, in anticipation of any slight mishap to the train-engine which might prevent a punctual arrival. As a result, not only was the run invariably made within the booked time, but on several occasions it was done in 5 or more minutes under time. In three instances, when I tested it, and when a special "spurt" was made, the times were respectively 57 minutes 49 seconds, 57 minutes 21 seconds, and 56 minutes 40 seconds. Down the falling grades toward Dunbar speeds of 80 to 85 miles an hour were attained, and the running was perfect in its steadiness.

On the London and North Western Railway, on January 5, 1862. a special train conveying some despatches relative to the "Trent" affair was taken from Holyhead to London, 264 miles in 5 hours, with

one midway stop at Stafford to change engines. The first run was made from Holyhead to Stafford, $130\frac{1}{2}$ miles, in 2 hours 25 minutes, or at the average rate of 54 miles an hour, by the engine "Watt," No. 224, one of Mr. J. Ramsbottom's "Lady of the Lake" class, having single driving-wheels of 7 feet 6 inches and cylinders 16×24 . This performance, both for average speed and for length of uninterrupted run, remained for many years unbeaten.

On December 20, 1895, the Great Western Company ran a special train from Plymouth to London to prove that arriving mails could be conveyed more quickly by that route than *via* Liverpool. The journey from Plymouth to London was made in 4 hours 27 minutes, including stoppages. The run from Exeter to Bristol, $75\frac{1}{2}$ miles, was done in 73 minutes, or at the average rate of 62.1 miles an hour; the run from Bristol to London, $118\frac{1}{2}$ miles, occupied 116 minutes, a



LONDON AND NORTH WESTERN "LADY OF THE LAKE."

Cylinders 16×24 ; driving wheels 7 ft. 6 in.; by J. Ramsbottom. One of the class which ran the special with "Trent" dispatches from Holyhead to London.

rate of 61.3 miles an hour. The engines used from Exeter to London were Mr. Dean's single-wheelers 7 feet 8 inches. The load was about 120 tons.

I have summed up briefly the circumstances and results of the most notable speed-trials on British railways. In doing so, I have attempted no comparison with the achievements of other countries. Those can speak for themselves. But I decline absolutely to believe that an ultimatum has been reached, in respect of possible speed, on either side of the Atlantic.

With the exception of the large picture of No. 116, Midland Railway, the illustrations of this article are taken from photographs published by F. Moore, 9, South place, London, E. C. All loads referred to are exclusive of engine and tender.

THE STEAM ENGINE AND THE DYNAMO— A CHAPTER IN EVOLUTION.

By Charles T. Child.

THERE have been no other industrial developments in the history of civilization so rapid and complete as those of the electric light and the electric railway. It is difficult to realize that only twenty-two years have elapsed since the dynamo machine made its first appearance and the electric light began to be talked about as a commercial possibility. No one could have then imagined the stimulus that its development would give to the art of engine building, and the problems that its increasing use would set for the mechanical engineer as well as for the electrician.

When the first Gramme and Siemens dynamos made their appearance, they were products of the instrument-maker rather than of the engineer. Practically nothing was then known of the laws of the magnetic circuit, or of the principles that underlay the correct design of electric generators. The consequence was that attempts to build large machines only demonstrated the necessity for further experience and greater knowledge, while the applications of the current were then so limited that there was but little occasion for the construction of electrical generators of large size.

It was not until after the Centennial exposition that the electric light was introduced on a practical and commercial scale. In the year 1877 the Jablochkoff candle was exploited in Paris and London as a practical illuminant, and the favour with which the new light was received proved a powerful stimulus to the growth of the infant art. By the middle of 1879 the incandescent light was introduced, and from that year the industry of electric lighting may be said to date.

The dynamos of that period were small, high-speed machines, generally of poor mechanical construction, savouring more of the laboratory than of the engineer's shop. The early arc-lighting machines of the Brush, Thomson-Houston, Gramme, and Weston types were limited both by mechanical and by electrical conditions to units of small size, capable of maintaining but few lights and demanding no very considerable power for their operation. When installed, usually in factories or workshops, or in some other place where power was used, they were generally belted to any convenient shaft, and allowed to regulate or not, very much as they pleased. With the arc machines accurate regulation of the speed was not so vitally necessary as it was soon seen to be for the later incandescent light machines; so the

general introduction of arc lighting made no demands upon the steam engineer that could not be easily met with the appliances then at hand. It is in connection with the development of the incandescent light that the problems of close regulation, high efficiency, and increased speed were attacked and solved, and the steam engine of to-day evolved from its predecessors of twenty years ago.

Probably the greatest improvement in steam engines since the days of Watt was that introduced by Sickels in 1841. This consisted of an independent "detachable" valve gear, so arranged that the steam which entered the cylinder and followed the piston from the beginning of its stroke was sharply cut off, at a moment determined by the governor, and permitted to work expansively through the rest of the stroke. The Corliss valve gear, a similar cut-off gear invented some years later, found great favour, and at the time of the Centennial it, or some of its modifications, was in almost universal use on engines of large power. The great majority of stationary engines of small and moderate size were, however, of the plain slide-valve throttling-governor variety, worked non-condensing. The ball governor, much as Watt left it, was still in almost universal use, though the loaded governor had found vogue among makers of Corliss-type engines, on account of its nearer approach to isochronism and its greater sensitiveness.

The high speeds of the early types of dynamos necessitated elaborate countershaftering and belting for their connection to the prime mover, and the serious losses of power entailed by transmissions of this character soon attracted the attention of engineers. Almost from the first the dynamo had shown a remarkable efficiency, and, with the advent of the central station for the distribution of electric light, and the really serious study of the economic side of the subject thus brought about, it became evident that either the engine speeds must be increased or the dynamo speeds lowered. With the electrical machinery any great reduction of the speed seemed then a virtual impossibility. It was argued that, from its very nature, the dynamo was a high-speed machine. Its output was directly proportional to its speed, and considerations of first cost demanded that it be driven to its utmost capacity. The same argument, as far as the relation between first cost, speed, and output was concerned, applied equally well to the engine, and it was natural that the first efforts to more closely accommodate the driving and driven mechanisms to each other should be in the direction of increased engine speeds. So long, however, as arc lighting monopolized the field, there was no very active effort made to change the prevailing state of things, since the dynamos rarely exceeded a capacity of thirty or forty horse-power each, and the large number of them required in a station of any

magnitude necessitated countershafting and belting. . The standard arrangement of an arc-light station about 1880 was a large slow-speed engine of the Corliss type, belted to one or more countershafts carrying driving pulleys for the numerous dynamos. The station was a maze of belts, but it was the best arrangement possible, and, with minor modifications, remains so to-day, in so far as series arc lighting is concerned.

The output of a dynamo is the product of the volume of the current it delivers by its tension or electrical pressure. In series arc-lighting machines the volume of current is kept approximately constant, the tension increasing with the number of lamps operated. When it is attempted to construct machines of large size to feed many lamps, the tension rises to such a degree that a limit is soon reached beyond which difficulties of insulation and the dangerous nature of the circuits prohibit extension. The largest single-circuit series arc machines absorb only about fifty horse-power, while none of the later types have yet been constructed of much more than twice this size.

With the dynamo for incandescent lighting, whether it be of the alternating or direct-current variety, and with the generator for electric railway currents, this limit of size does not exist. In them the tension is maintained as nearly constant as possible, while the volume of current delivered and the power absorbed vary with the demands of the working circuit. There is, consequently, no limit imposed by electrical considerations to their size and power. This was recognized at an early date, and with it the great improvement in efficiency and economy that would result from the construction of large machines to supply electricity from central stations. Unfortunately the total incompetence of the steam engine to perform the severe duty demanded of it by this type of machine was also but too soon evident.

For incandescent lighting an absolute essential is the maintenance of a constant electrical tension upon the supply mains. The smallest variations produce an unpleasant flickering of the light, while larger ones result in disastrous shortening of the life of lamps and unpleasantly significant figures in the balance sheet. Steady tension under varying loads means steady speed of the dynamo, and, since any variation of the speed produces a greater corresponding variation of the tension and a still greater variation in the light from incandescent lamps, the steadiness of the engine speed must be almost absolute to insure commercially-successful operation. It is easy to see what a problem confronted engineers suddenly called upon to cope with these new conditions and armed with no better appliance than the ball governor of Watt.

The efficiency of the large independent valve gear engines, in use

at the time when the extension of central-station lighting gave rise to the new demand for perfect speed control, left very little to be desired. The most obvious improvements to be sought were the increase of engine speeds, the shortening of the stroke to diminish cylinder condensation, and the elevation of working pressures. Evidently, other things being equal, a high-speed engine will more quickly accommodate itself to a changing load than one working at slower speed, while the effectiveness of a fly-wheel in smoothing out the varying torque due to reciprocating piston motion increases rapidly with the speed of rotation. It seemed, therefore, that higher speeds would not only improve the efficiencies of existing types to some degree, but also assist materially in the solution of the difficult problem of regulation.

At the outset of the movement for high speeds it was recognized that the independent valve gears then in use would not accommodate themselves to very fast running. Some form of positive valve gear must be used, and the high efficiency of the detachable gear must be sacrificed to the exigencies of regulation and speed. Precedents could not be considered in the design of an engine which deliberately set out to accomplish what was then thought to be the impossible.

The first high-speed automatic engine for electric lighting, the invention of Messrs. Porter and Allen, was a very radical departure from the standard type in many ways. The quick-acting induction-valve of the Corliss type was replaced by a variety of piston valve, while the older type of separate exhaust valves was retained; but the main departure, aside from the speed of running, was the method of governing. An eccentric on the main shaft of the engine operated the exhaust valves, and also a link into which the induction-valve rod was geared. The governor, a weighted-ball affair, varied the position of the attachment of the rod to the link, and thus changed the point of cut-off.

Higher speed meant the increase of the various stresses incident to the starting and stopping of the reciprocating parts, increased friction, much greater need for rigidity in the bed of the engine, and more accurate alignment. It is doubtful if the great speeds successfully attained in the early electric-light engines would have been possible, had it not been for the great improvements in nearly all forms of machine tools that had been lately perfected.

Strength, as well as accuracy of workmanship, was an essential feature in the construction of engines that were to run at three hundred revolutions per minute, or more. At that speed the piston, piston-rod, and cross-head must be started from rest, accelerated up to full speed, and stopped with the least possible shock, no less than ten times a second.

The shorter stroke of such engines enabled their designers to make them very compact, and, by shortening the bed, to greatly improve upon the rigidity of older types. A double economy in space was secured at the same time, since the shorter stroke diminished the length of the engine frame, while the increased speed multiplied the power output proportionately.

For about two years the pioneer high-speed engine was alone in the field, an object of cavil for the older engineers who believed in slow piston speeds and the quick cut-off and "square-cornered" indicator diagram of the detachable valve gear engine. When, however, its success in driving electric-light machinery became evident, and the demand for accurate-governing, fast-running engines became pressing, new types began to appear from all sides. Attached to one of the first of these was a shaft governor, perhaps the next greatest advance in the art of engine building after the detachable valve gear and automatic cut-off regulation. This governor operates by shifting the eccentric with reference to the shaft, so that the throw is increased or diminished, thus varying the cut-off. Generally these engines have but one valve, and their simplicity and excellence of design combined to make them admirably fitted for the work they were called upon to perform. The problem of regulation had been solved, and at the same time speeds so increased that the dynamo and engine could be belted directed, or even mechanically coupled together if the dynamo was very large. As early as 1883 an incandescent light dynamo of considerable size, directly coupled to an engine running at 350 revolutions per minute, was exhibited, and combinations of this character were used in the early central stations in New York. The engine had been improved out of all resemblance to its former self, and its speed trebled or quadrupled, but the dynamo obstinately remained a high-speed machine.

In 1888 the electric street railway opened a new field to builders of engines and dynamos. The requirements of this service were even more exacting than those of electric lighting, for the variations in the load far exceeded those of the illuminating circuits both in suddenness and magnitude. Both engine and dynamo were subjected to stresses that had not been encountered before, and both suffered. It was seen that engines for railway service must be made heavier and stronger, that their design must be modified to conform to the exigencies of the new service, and that a large fly-wheel was able to tide over many of the brief overloads common in railway work. The dynamo was by no means so well adapted to the severe requirements of electric-railway work as the engine. Practically all dynamos, at the period referred to, had smooth-core armatures of the cylinder type, though

some were built with Gramme ring armatures. Only one commercial machine had a toothed-core armature. The Gramme rings were deficient in mechanical strength and expensive to wind, besides being organically liable to disastrous ailments; so they soon disappeared. The smooth-core cylinder armature was cheap and simple, but it possessed some inherent defects whose removal marked one of the longest steps in the progress of dynamo development. The first improvement to be generally introduced was a system of winding that used machine-made coils instead of hand-winding. The attachment of the coils to the armature core was generally by wooden or metallic driving keys, and through these the whole power of the engine was necessarily transmitted. A heavy short-circuit has been known to strip every wire loose from the core of a smooth-bodied armature. Over the outside of the mass of wires forming the winding were binding bands of other wires, the whole forming a structure that was mechanically frail and not easy to insulate against the electrical pressures employed in railway work.

But, aside from these mechanical deficiencies of the older type of armatures, there was a grave electrical difficulty in the necessarily wide gap between the iron of the armature core and the stationary pole-pieces of the machine. In this space were included the windings and the clearance needed for safety between them and the pole-faces, in all a considerable layer of highly-resisting medium through which the magnetic induction of the fields must penetrate. The remedy for both the magnetic and mechanical troubles was obvious, and was quickly applied. Dynamos appeared having their armature windings deeply sunk in slots or tunnels in the metal of the armature core, leaving the surface of the armature clear of wires, and enabling it to approach the pole faces as closely as mechanical safety of running would permit. At once the speed of rotation was also reduced, as, in the far stronger magnetic field secured in this way, a less peripheral velocity of the armature windings was needed to secure the same electrical results. The new construction, in addition to greatly enhancing the mechanical strength of the armature, had also the advantage of permitting better insulation of the windings, and thus almost entirely obviated their accidental destruction.

As the stations for electrical generation grew large, the size of dynamos increased in proportion. The larger the machine, the less its first cost proportionately to its output, and the less house-room requisite for its installation. The increase in size naturally meant a decrease in speed, while the multipolar construction adopted for the largest dynamos involved a still further lowering of the necessary revolution rate. It is now evident that the dynamo could be made,

in large sizes, for a normally slower speed than that of the prevalent type of dynamo-driving engine.

When the change to high speeds in engines was made, there had been a sacrifice of economical steam consumption to secure the increased velocities and quicker regulation. The single-valve automatic engine was a signal success under certain conditions, and wonderfully well adapted for use in small units, but it was not efficient. Neither compounding or the use of a condenser would make it as economical as the Corliss type under similar conditions, especially after the latter had been improved by the substitution of spring-driven cut-off gear for the old gravity type, and set to work at somewhat higher speeds than formerly. There was now a wide range of speeds at which both engines and dynamos could be efficiently operated, and the direct coupling together of the two machines began to be the rule rather than the exception.

With the growth of systems and stations came also an increase of confidence in the good qualities of large dynamos and engines, and an increasing tendency to adopt very large units. Engines of a marine type, having vertical cylinders, direct-coupled to large generators, came into vogue in England and Germany, and American engineers were not slow to see the excellence of this arrangement for very large units. A recent example of a combination of this sort is used for the generation of alternating currents for lighting purposes. The engine part is a two-cylinder vertical cross-compound of 2,000 nominal h. p. The dynamo has an output of 350 amperes at 2,400 volts on each side of its two-phase circuit, and furnishes current for lighting 30,000 incandescent lamps of sixteen candle-power each. The combined machine, engine, and dynamo, each of whose parts was designed with reference to the other and to their efficient action when operating together, occupies a space of 33 by 28 feet, and is nearly 23 feet high. There is no fly-wheel, the 75,000-pound armature taking its place. The speed is 116 revolutions per minute.

This combination is typical of the best modern central-station practise. In isolated plants, or where there is a demand for smaller generating units, the high-speed automatic engine direct-coupled to an appropriate dynamo enjoys much favour. For train lighting, yacht lighting, and other isolated installations of very small size, direct-connected units operating at speeds as high as 600 revolutions per minute have been successfully used. On the other hand, where conditions require it, dynamos are built for very low speeds, one recent water-power installation in Switzerland using dynamos of large size and power running at only $28\frac{1}{2}$ revolutions per minute.

The cognate development of the dynamo and its driving engine

has thus been directly responsible for the appearance of the high-speed automatic cut-off engine, and its wide use during the period of experiment and study in which the true laws of the dynamo were discovered. With the coming of greater experience and the demand for larger units, the less efficient high-speed engine has been forced to give place to its predecessor, the detachable valve gear engine, but the latter has been profoundly modified as the result of the experience gained during the years while the automatic type held undisputed sway. The shaft governor, the piston valve, and the crank-disc are some of the features of the automatic type that survive in the modern, large-sized, dynamo-driving, detachable-gear engine.

A new departure, however, in steam engineering, the steam turbine, promises to drive dynamo designers to the consideration of the very highest speeds for their machines. The remarkable efficiency of the steam impulse wheel, its extraordinary simplicity, and the high output of power per unit of weight secured by its use, make it the ideal machine for the conversion of thermal into mechanical energy and for dynamo driving, save for the one almost fatal difficulty of its enormous and unmanageable speed of rotation. The wheel rotates at great speeds, often as high as 30,000 revolutions per minute. So far the unmanageable velocities encountered have forbidden the commercial extension of the method, though some combinations of steam turbine and dynamo are successfully working under commercial conditions. Hitherto no attempt has been made to design a dynamo for direct operation at the speed of the turbine, but the effort has been to reduce the speed, either by gearing or directly, to that of the present types of dynamos. The analogy of the case of dynamo and reciprocating engine twenty years ago seems to point to some compromise method. Certainly gearing will never be tolerated, so long as there is the least hope of directly reducing the speed of the steam turbine. There appear to be good grounds for thinking that compounding offers a solution of the difficulty, and that speeds as low as 2,500 revolutions per minute may be had directly from a multiple-wheel, multiple-expansion turbine. It is not, therefore, beyond the bounds of possibility that our future central stations will contain no reciprocating machinery larger than a boiler feed pump.

There seems to be no limit in sight at which the growth in size of the dynamo and engine combination must cease. Marine types of engines of great efficiency are now in use on the better class of passenger steamships, in units as large as 15,000 h. p. While the largest dynamos now at work are only of 5,000 h. p., it is safe to say that there is no reason whatever why they cannot be made to-day three or four times as large, should there be any occasion for their construction.

THE GAS ENGINE IN AMERICAN PRACTICE.

By George Richmond.

EUROPEAN writers usually dismiss the subject of American gas engines with a few brief paragraphs, and the inference that little has been contributed by this country to the development of the gas engine is justified, to a certain extent, by the facts. Until recently an account of American engines would have been merely a repetition of the description of European types, and not the most modern types at that.

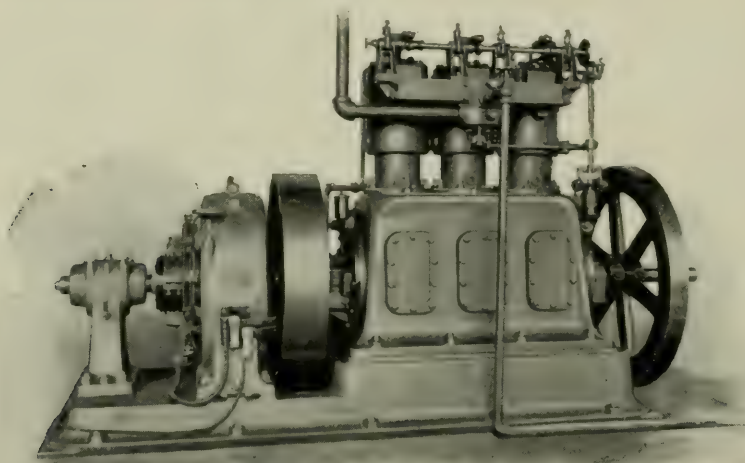
The slow growth of this industry in the United States has sometimes been attributed to want of enterprise on the part of those having the Otto patents, which for a time practically controlled the business. But we do not find the same activity as in Europe in designing substitutes for the Otto Cycle, nor did any of the imported substitutes obtain any foothold in this country ; so that we must look for other reasons.

The most important of these are : first, the lesser number of small industries in this country, requiring a moderate amount of power ; second, the greater cheapness of coal, together with the higher price of gas, both actually and relatively. To these causes may be added the higher rate of interest in America, rendering the investment in a high-priced gas engine a serious charge upon a business. That this latter consideration was really a potent factor in retarding the growth of the gas-engine business is shown by the fact that, immediately after the expiration of the Otto patent, the market was flooded with engines whose chief characteristic was cheapness. This cheapness was effected in part by simplification of details, more or less successful, but chiefly by reduction in strength and over-rating of capacity. A healthy reaction, however, is distinctly noticeable, and it is reasonably certain that in a short time high-grade gas engines will be sold in America at less per horse power than in any country in the world. And this result will be brought about by factory methods of manufacture in quantities, and excellence of design and workmanship, rendering possible high rotative speeds,—not by niggardliness in parts and proportions.

Had the gas-engine business continued to be confined to the manufacture of very small engines, the electrical distribution of power would have proved a very serious rival. As it is, however, electricity seems destined to prove a most valuable ally, which will lift the gas engine into serious rivalry with the steam engine itself.

It has been shown that in practice a given volume of illuminating

gas employed in a gas engine to generate electricity will furnish nearly twice as much light as if burned in the ordinary manner, and, although the incandescent gas burner may to a certain extent offset this in towns, the internal combustion engine, using oil or gasoline, will remain the cheapest and simplest means of producing electricity for country houses, village communities, etc.



WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S 3-CYLINDER
GAS ENGINE AND DYNAMO.

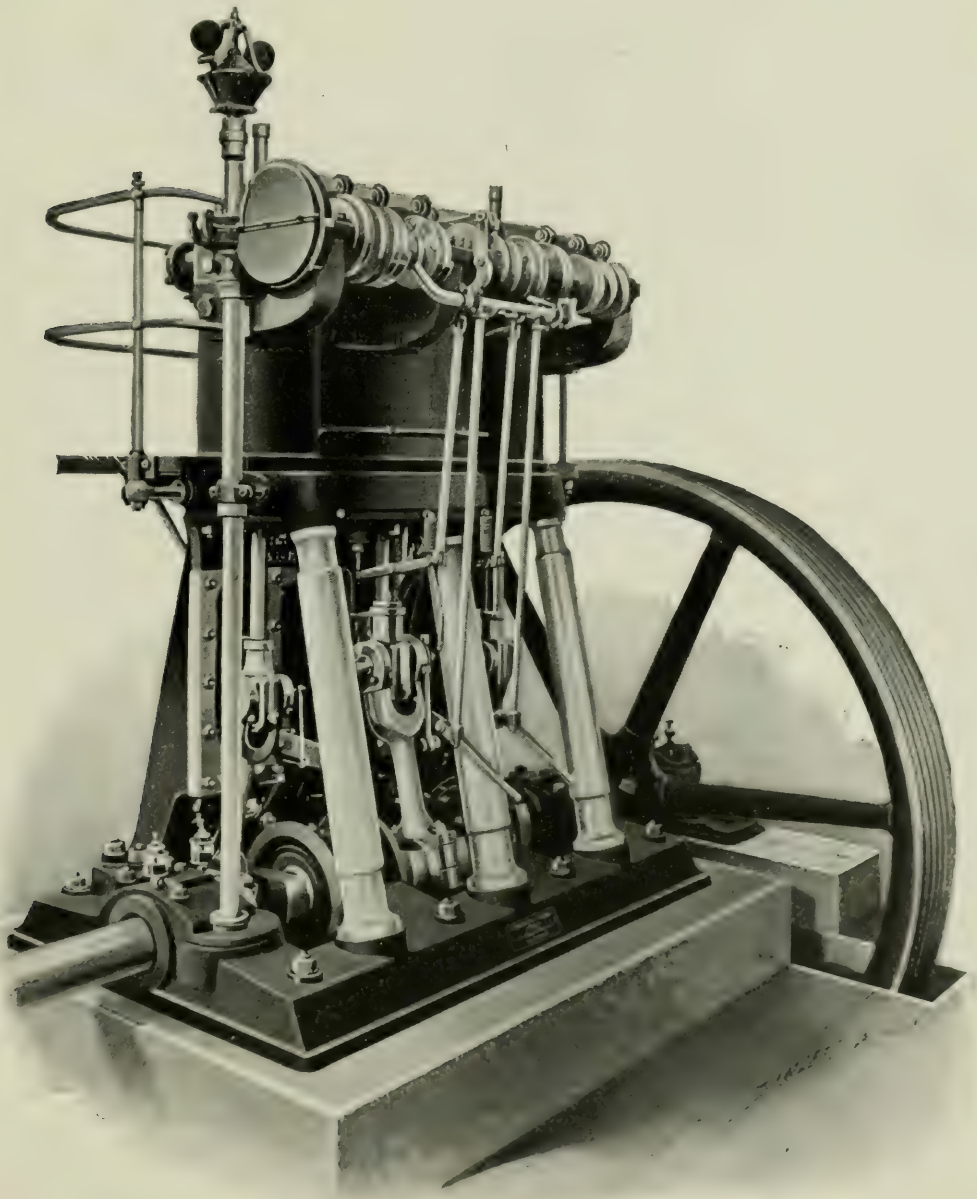
The development of electrical industries, on the other hand, has caused a demand for power in so enormous quantities that economy of fuel becomes a more and more important consideration.

When reliable gas engines of 1,000 h. p. and upwards can be operated with from half to three-quarters of a pound of coal per horse power per hour, we may look for the gradual displacement of the steam engine in power houses. We are assured that the building of such engines is only a question of time, and that the greatest present obstacle is the absence of a suitable producer adapted to furnishing gas from the cheaper grades of coal. The fact that large and wealthy firms are devoting considerable energy and lavish expenditure to this work is an evidence of confidence in the ultimate result of their efforts.

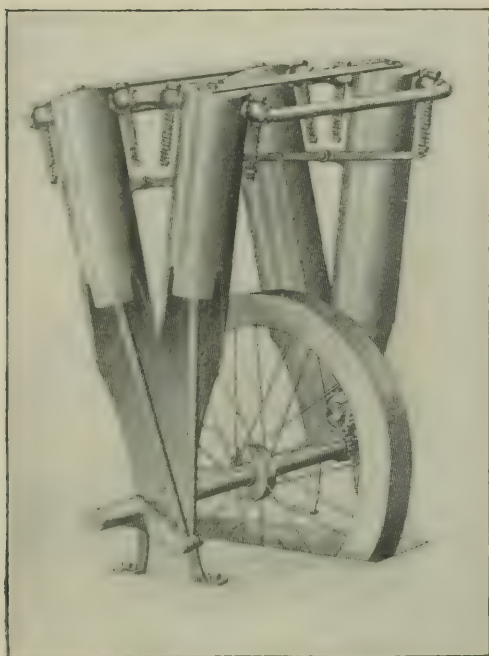
In the shops of the Westinghouse Machine Co., a gas engine of 750 h. p. convertible into 1,000 h. p. may be seen, and it is understood that the company is preparing to build still larger sizes. It is said, also, that Krupp is to build a 1,000-h. p. Diesel engine for the Paris Exposition of 1900.

The Brayton engine is perhaps the best example of an internal combustion engine of distinctly American origin, although it is claimed that Sir Wm. Siemens proposed the same cycle at a much earlier date. Brayton, however, was the first to produce a workable

oil engine of the type in which the air is compressed in a separate cylinder and combines with the oil in a working cylinder, the intention being to continue the combustion at a constant pressure during a portion of the working stroke, after which the supply of oil is cut off and expansion continues during the remainder of the stroke. The governing is effected by varying the point of cut-off of the oil, and the diagram produced is very similar to that of a steam engine operating with varying cut-off.



150-H. P. 3-CYLINDER DIESEL MOTOR.



THE KANE-PENNINGTON 4-H. P. MARINE
ENGINE. WEIGHT 50 LBS.

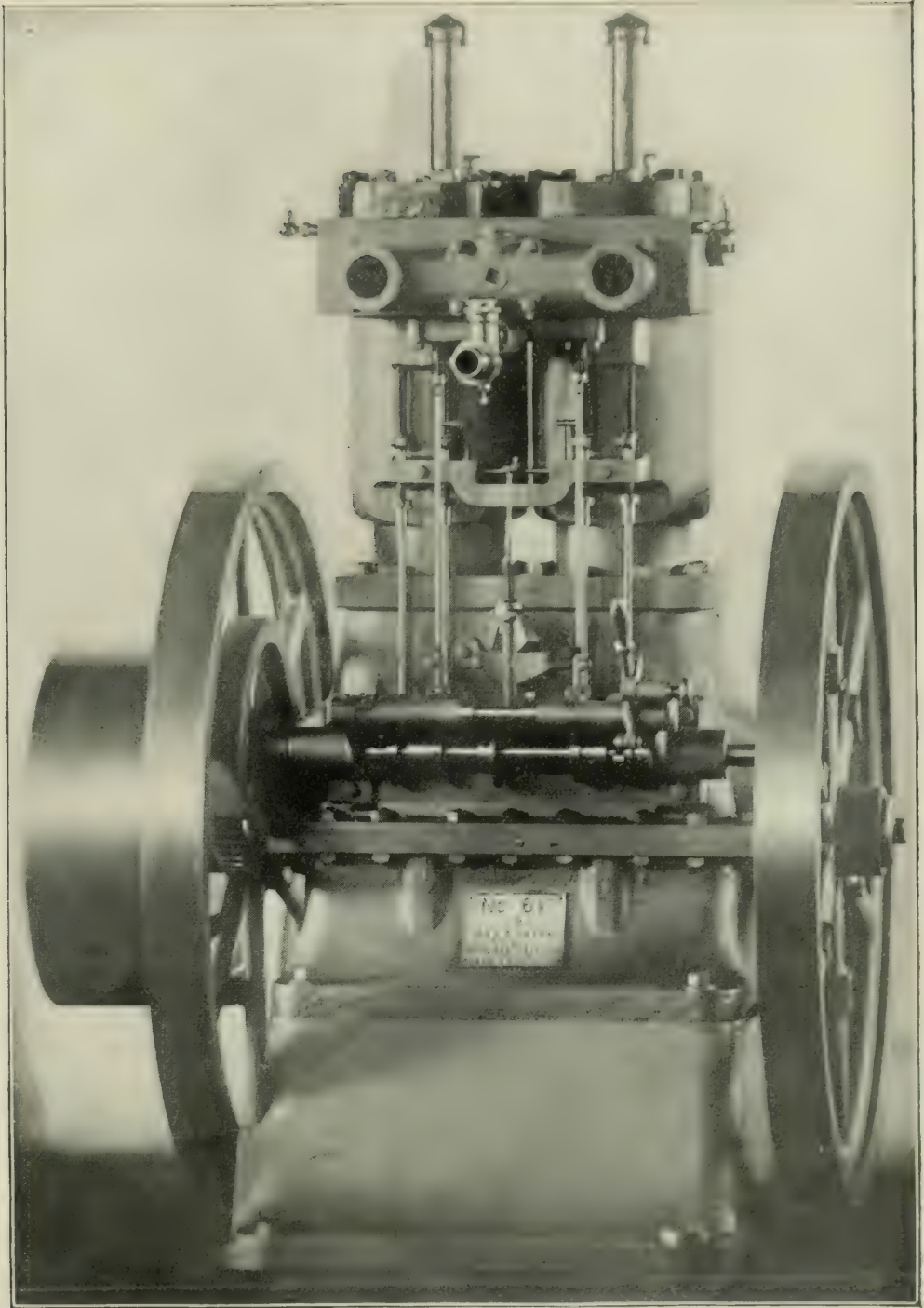
It is interesting to note that the Diesel Rational Heat Motor, when using liquid fuel, operates in precisely the same manner as that of Brayton, except that it aims to obtain combustion at a constant temperature instead of at constant pressure. In this respect the cycle of the Diesel engine is theoretically inferior to that of Brayton. Diesel, however, developed the idea to a brilliant success, while Brayton's engine was a failure.

The cause of Brayton's failure lay in the means of ignition; Diesel avoids this by increasing the compression to the point at which ignition is automatic.

It is to be feared that at the present time Europeans associate

the idea of American gas engine design with the Kane-Pennington engine. Our English cousins have paid a very large price for the privilege of controlling the manufacture of this remarkable engine, and are interested in certain "foreign syndicates" for the granting of like privileges to other nations. It would be interesting to collect the expert reports and technical-journal descriptions of this engine. There is, indeed, about it, a democratic simplicity and an ignoring of conventional rules of construction that are truly characteristic; moreover, the boldness of the conception of the "ripening and cooling" spark was hardly less startling than the seriousness with which it was discussed. To show that this is not all that the United States have contributed to gas-engine design, a number of cuts of engines are given with this paper. They have been selected on account of the novel and distinctly American treatment of the subject. As there are more than fifty firms in America engaged in building gas engines, it was necessary to select the illustrations on a somewhat narrow basis, and all engines of the standard European design have been excluded.

It is not asserted that these are the best gas engines built in America, or even that the boxed-in multiple-cylinder type will eventually prove the most satisfactory. It is the type, however, which at present commends itself to the most enterprising American firms, and it will be interesting to watch its development.

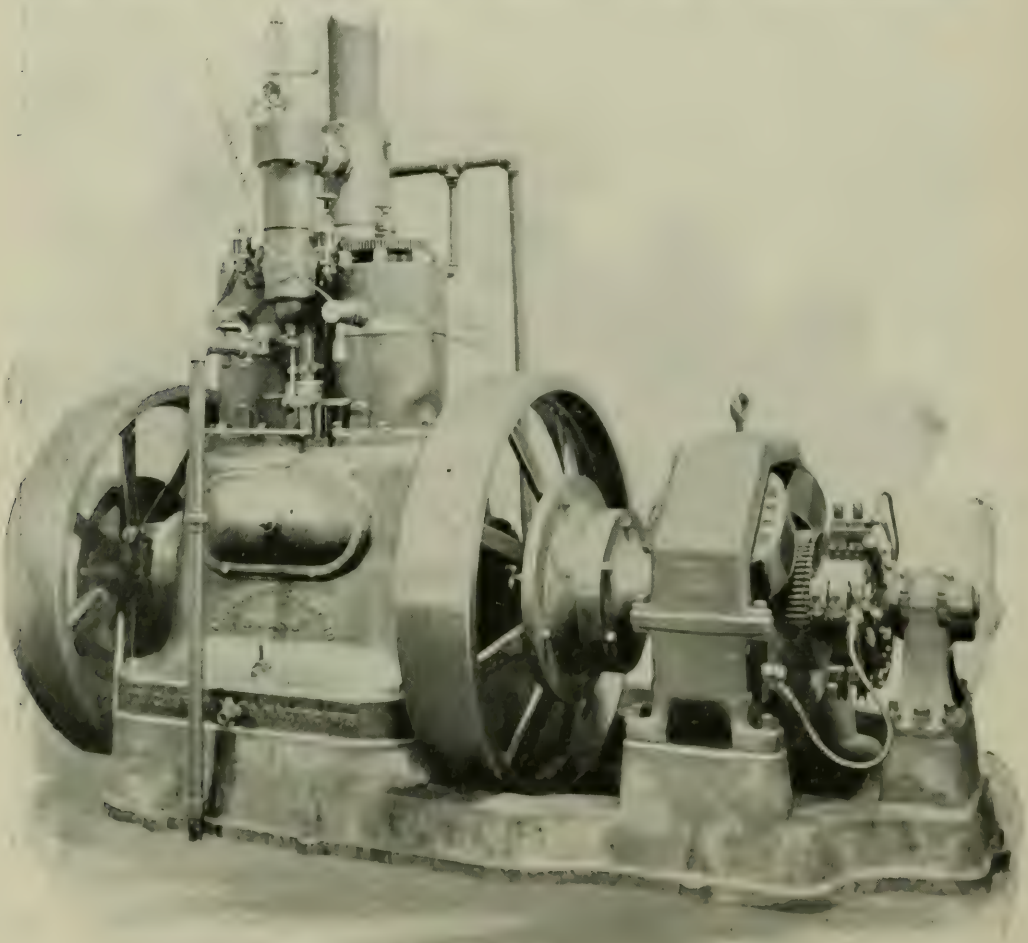


15-II. P. NASH GAS ENGINE WITH INCANDESCENT-TUBE IGNITER.

About the time the United States exported the Kane-Pennington engine to Europe, the Gardie engine was brought over from there, and had a brief and inglorious career under the Americanized name of the "Bates Triple Thermic Motor." In this case, as an example

of the uncertainty and injustice of fate, an extremely ingenious engine the theory of which, together with the working details, had been elaborated with the most careful and intelligent industry, was allowed to drop into undeserved oblivion as an instrument of a stock-jobbing fiasco. It reached the United States loaded up with too ingenious and complex mechanism, and at first sight seemed a proper object for simplification and development by American mechanics. Gardie, in his patent specification, describes his engine with remarkable clearness as follows :

“My new engine operates on the following principle. The gas issuing from a special generator is conducted to a compressor. At the same time air is compressed in another compressor. By reason of their compression the gas and the air are heated to about 200° Centigrade. The gas and the air thus compressed are further heated to about 400° by being passed separately through heat-regenerators,

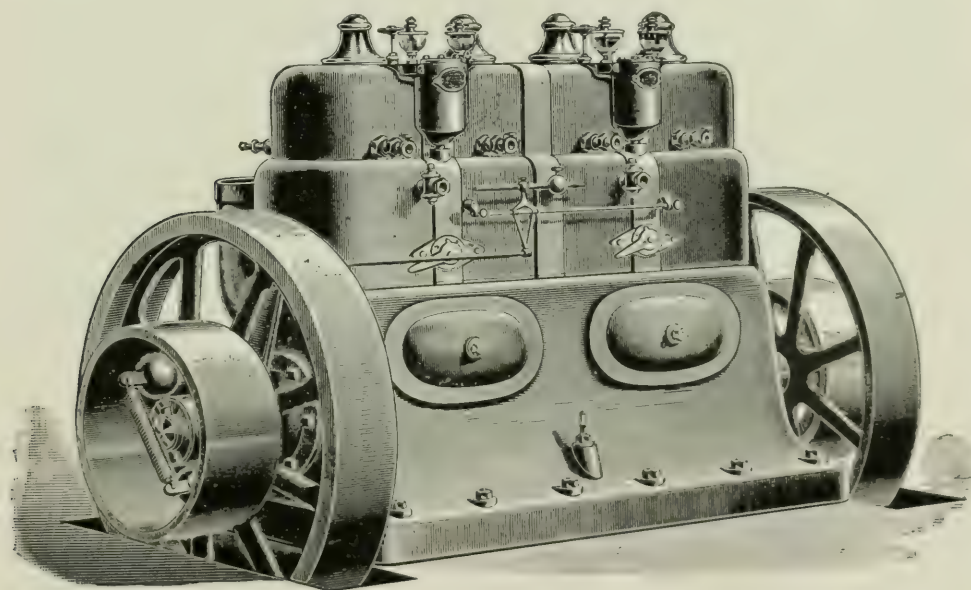


J. I. CASE T. M. COMPANY'S 2-CYLINDER GAS ENGINE, 30-H. P., DIRECT-CONNECTED TO DYNAMO.

after which they are conducted to the motor-cylinders, being discharged thereinto in thin jets or layers, the jets of gas and air being alternated. In the motor-cylinders the gaseous mixture is caused to burn by coming into contact with an igniter, and, by reason of the combustion, the temperature rises to about $1,500^{\circ}$, the expansion of the gas forcing the pistons to move in the cylinders. By reason of the expansion, the temperature falls, and the spent gases, still hot, are discharged from the cylinders and utilized in the regenerators for heating the gas and the air, which are on their way to the motor-cylinders."

Just as American engineers were beginning to feel that they were catching up, and had nicely recovered from the temporary shock of the Bates Triple Thermic motor and its five-million-dollar company, a new record-breaking gas engine was presented to them in the form of the Diesel Rational Heat Motor. At present a company with \$1,000,000 capital is acting as advance agent, and by the time this is read an engine will be in operation in the United States. If it is handled there with the consummate business ability that has been shown in Europe, its claims cannot fail to attract the earnest attention of all engaged in the gas-engine business.

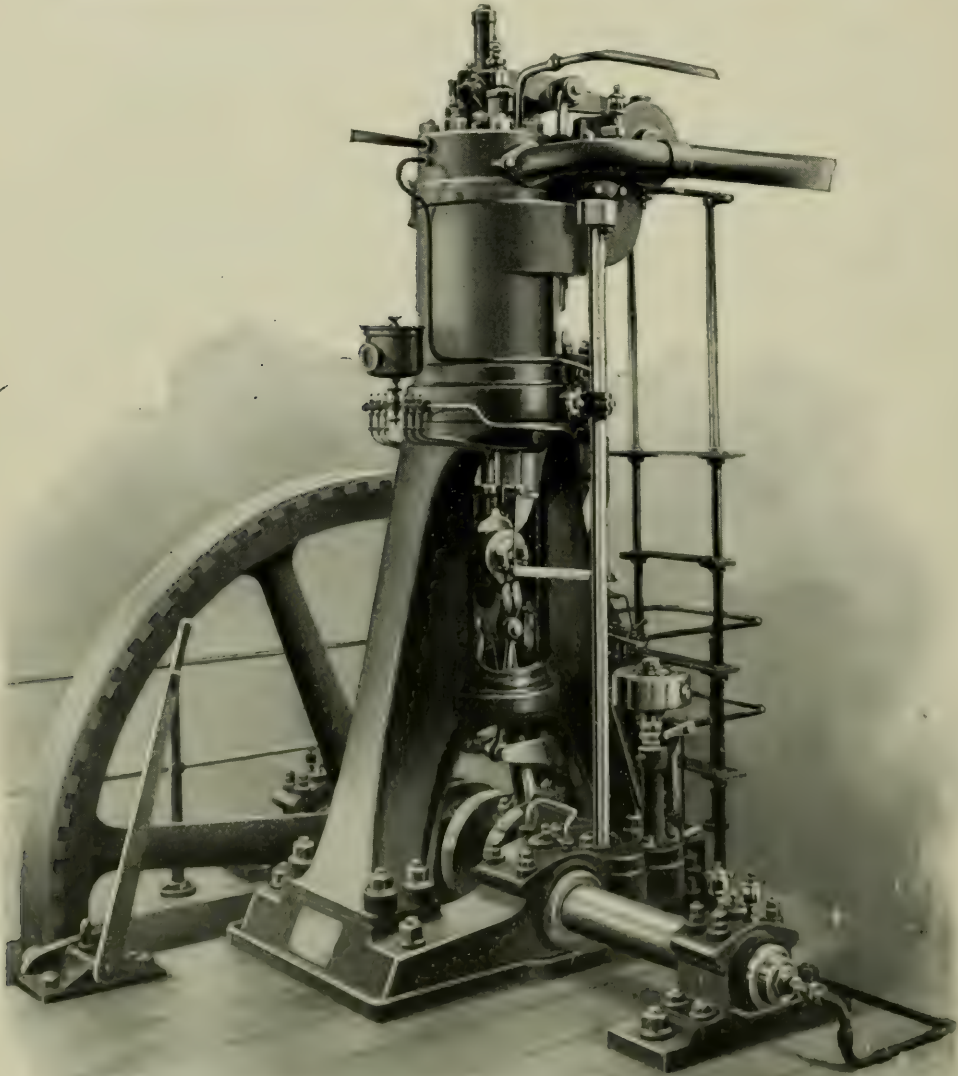
The Diesel Motor belongs to that class of which the Brayton and Gardie motors are the most conspicuous examples,—namely, that in which the air and fuel are separately compressed and subsequently brought together for ignition. In the Diesel motor, however, pressures are used which have never been attempted, and it is indeed a tri-



J. I. CASE T. M. COMPANY'S 4-CYLINDER 80-H. P. GAS ENGINE.

umph of shop-work that a gas engine compressing to 35 atmospheres should operate with a mechanical efficiency of 75 per cent.,—the result shown by the test of Prof. Schroeder when the engine was running at full load.

As was to be expected, the use of these high pressures, under me-



20-H. P. DIESEL MOTOR.

chanical conditions so favorable, results in a thermic efficiency higher than has hitherto been obtained. By thermic efficiency is meant the ratio of the heat converted into work to the total heat supplied to the engine. Theory calls for an increase of thermic efficiency with increase of compression. It was the adoption of prior compression of

the charge that gave the gas engine an efficiency which justified its adoption as a commercial machine. Makers have slowly increased the compression,—with some hesitation and misgiving, but always with increase of efficiency. The table given below shows this progressive increase of compression and the accompanying increase of efficiency.

“Absolute indicated efficiency of Crossley Otto Engine of similar size, since 1882.”

	Efficiency.	Pressure of compression above atmosphere.
(1) 1882–88	0.17	38 lbs per sq. in.
(2) 1888–94	0.21	66.6 “ “
(3) 1894	0.25	87.5 “ “

Dugald Clerk, who gives this table,* recorded in the February number of this magazine an efficiency of 30 per cent., with a compression of 95 pounds.

With a compression of more than 450 pounds to the square inch, the experimental motor of Herr Diesel has shown an efficiency of more than 34 per cent. The bold jump taken in the case of the Diesel Motor is, therefore, rather disappointing in its results. It has shown that, contrary to the opinion of conservative gas-engine experts, it is possible, with the excellent workmanship of the Augsburg Machine Co., to run an engine successfully with these high pressures. It seems, however, to confirm the opinion that the net increased efficiency so obtained is small compared with the increase of compression. The comparison, however, is not entirely just, for the reason that in the Diesel engine the compression pressure is, theoretically, the maximum pressure, which is far from being the case in the ordinary Otto engine. In the instance just quoted, where the compression amounted to 95 pounds, the maximum pressure after ignition was 310. So far, therefore, as the mechanical difficulties are concerned, the comparison should be between pressures of 310 and 450 pounds respectively.

The theory of the Diesel motor is very simple. In it an endeavor is made to follow as closely as possible the Carnot Cycle. In practice, however, the only modification of the Beau de Rochas Cycle attempted is in the period of combustion. In the Beau de

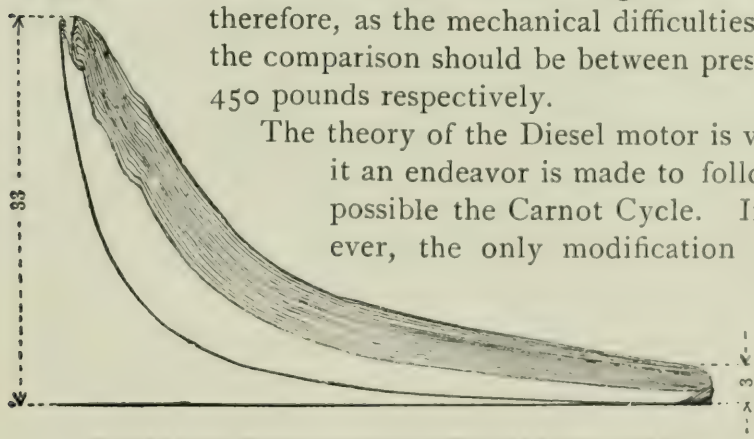
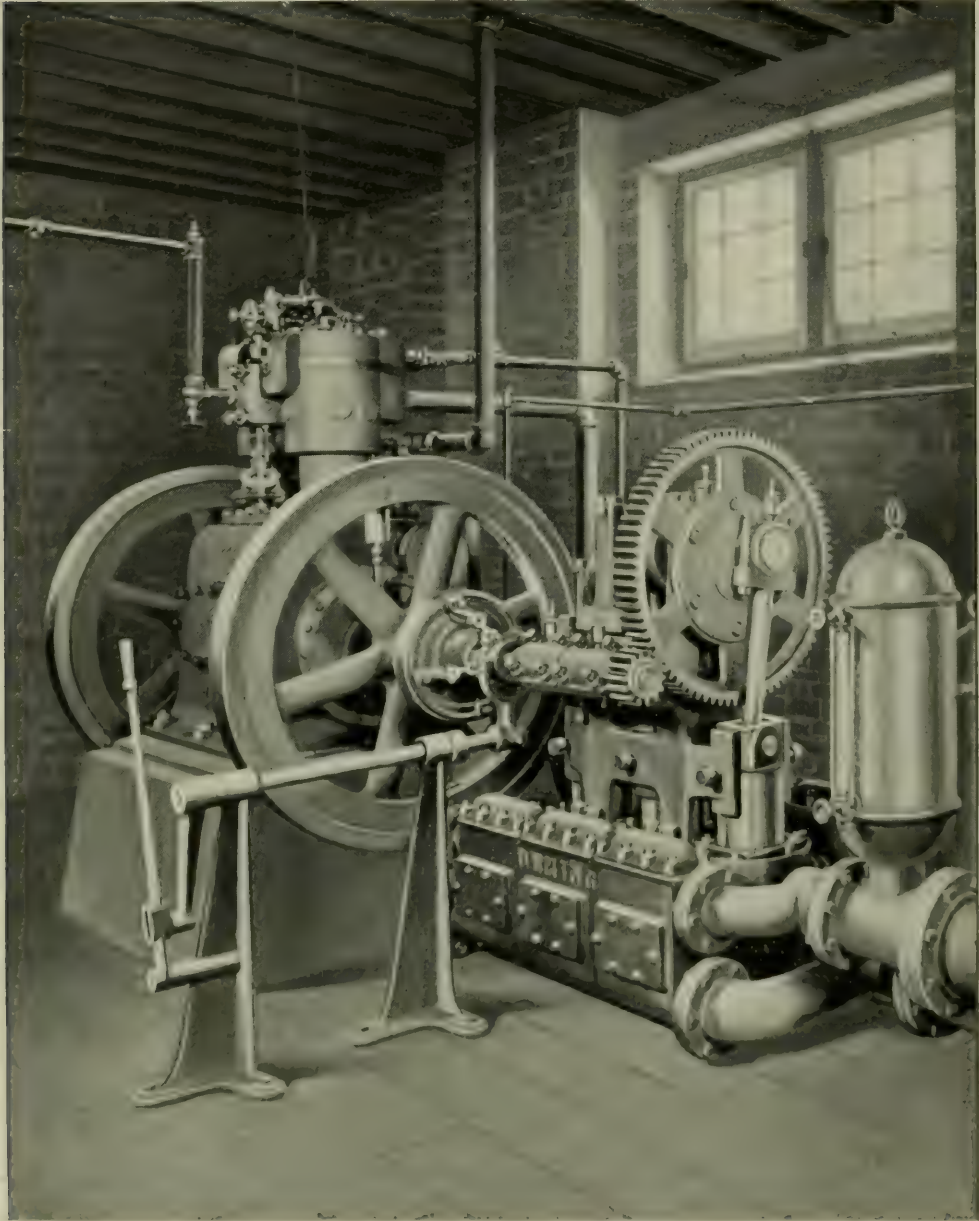


DIAGRAM OF DIESEL MOTOR UNDER VARYING LOAD.

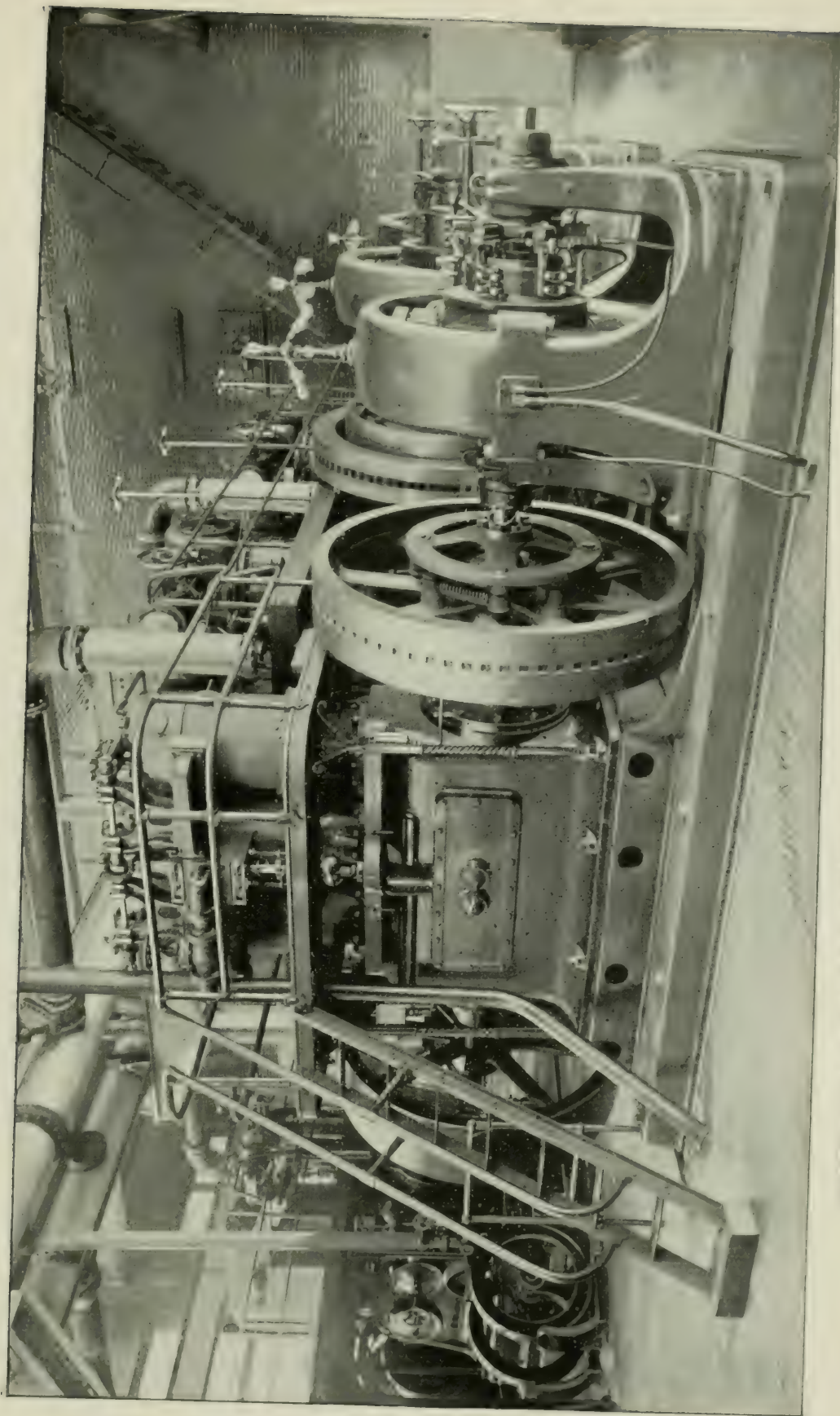
* "The Gas and Oil Engine," p. 376. Dugald Clerk. J. Wiley & Sons.

Rochas Cycle the combustion takes place at constant volume ; at least, it is presumed to do so, although, as a matter of fact, about one-half of the total heat is generated at constant volume, and the remainder during the expansion of the ignited mixture. The Carnot Cycle requires

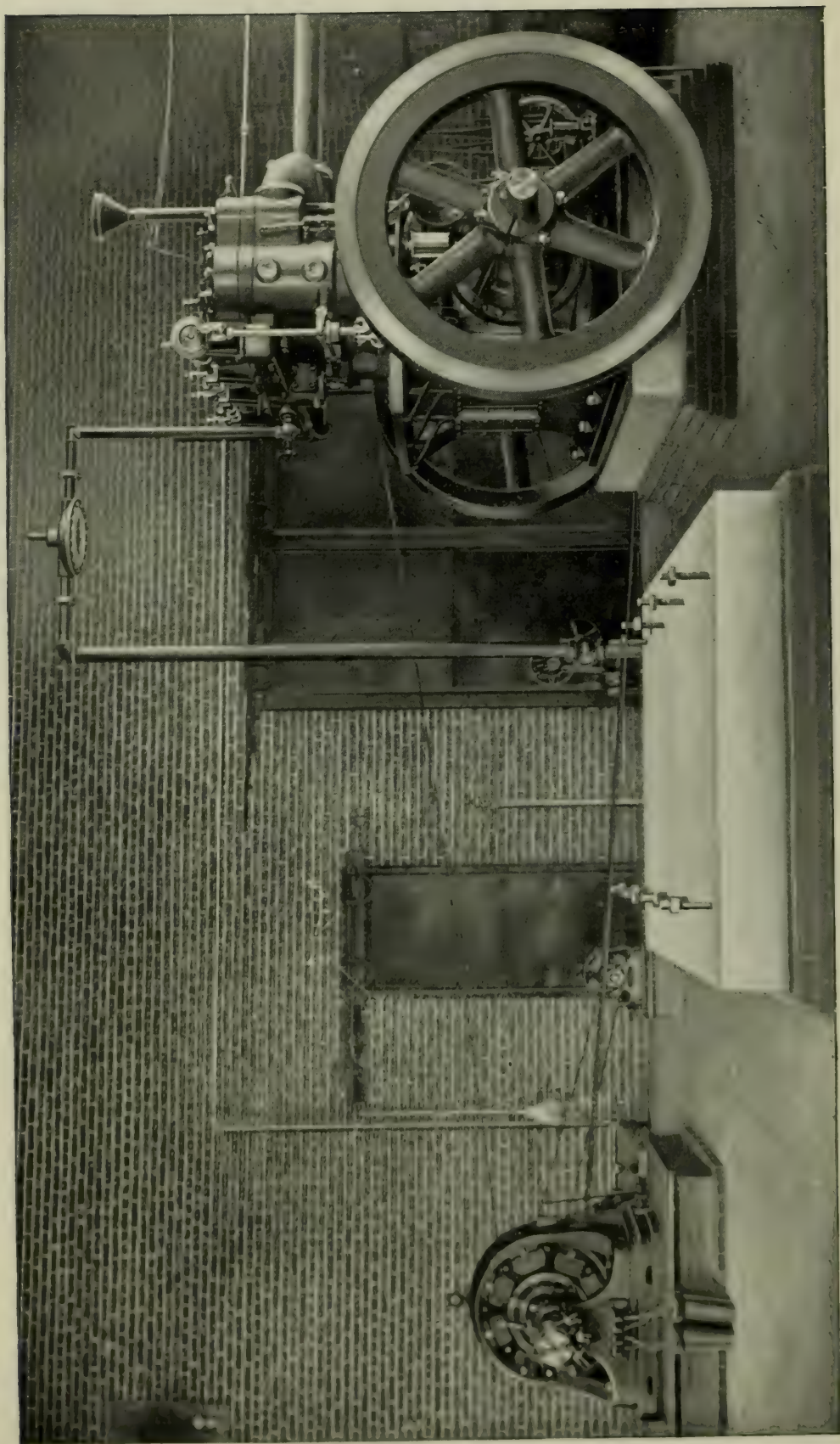


WESTINGHOUSE GAS ENGINE IN EAST PITTSBURG WATER CO.'S PUMPING PLANT.

that the heat should be supplied at constant temperature, and in the development of the Diesel motor a vast amount of ingenuity and patient experimenting have been expended on means of insuring this isothermal combustion. The air having been compressed until the



WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S POWER HOUSE, WITH 2,250-H. P. GAS ENGINE.
The 600-h. p. steam engines, directly behind the gas engine, afford an idea of comparative size.

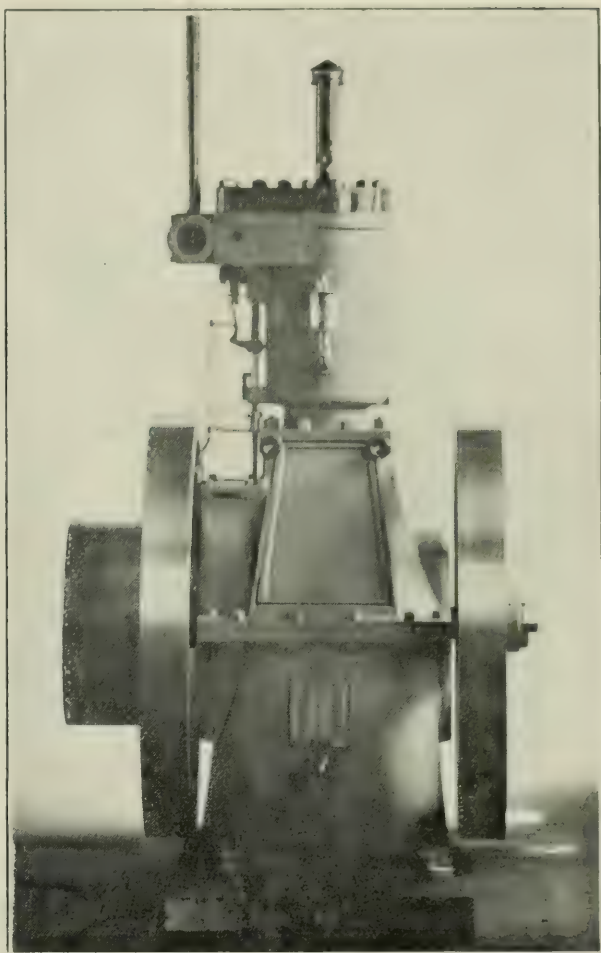


LAFAYETTE, IND., U.S.A. CENTRAL-STATION PLANT, RUN BY TWO 125-H.P. WESTINGHOUSE GAS ENGINES.

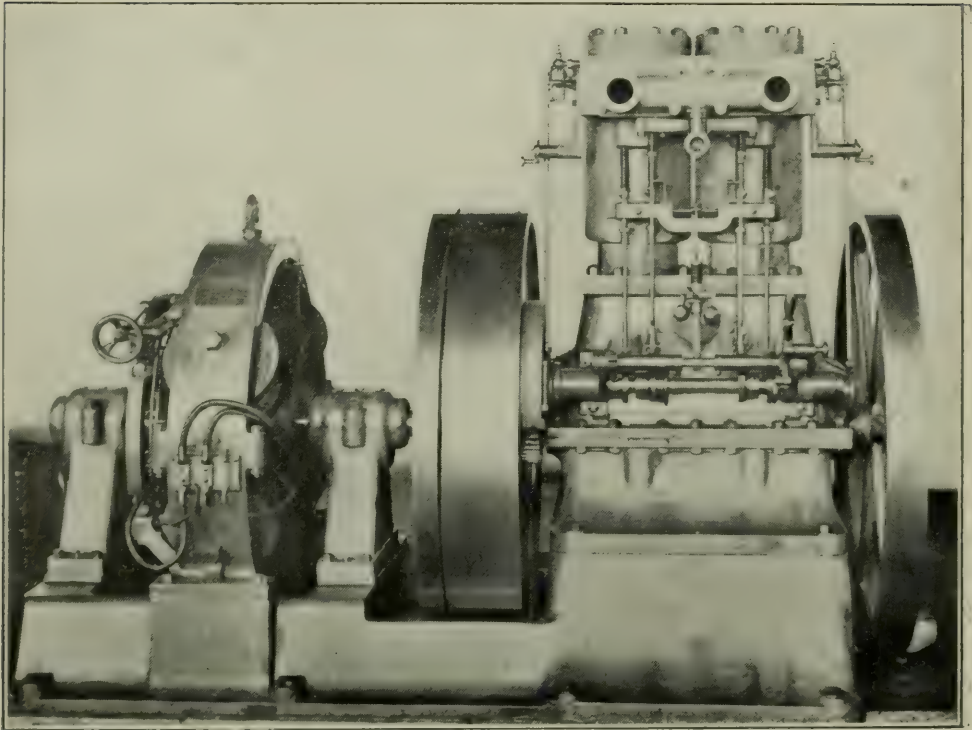
temperature due to compression is equal to, or higher than, that required for combustion, the fuel under still higher compression is fed gradually into the hot air during the first part of the expansion stroke.

The heat generated by the resulting combustion, instead of raising the temperature, is so controlled as to balance the heat disappearing by conversion into work. Thus, during the supply of the combustible, the temperature remains the same, and, when this is cut off, the temperature falls, in consequence of the work done by adiabatic expansion. It is to this isothermal combustion that Diesel attaches the

greatest importance. It is obvious that, with the most delicate and complex mechanism, it can be only approximately obtained, and the belief in its advantage appears to be based on a misconception of the doctrine of Carnot, or, rather, a misapplication of it that is not at all uncommon. Carnot enunciated the principle that temperature is the significant factor in the efficiency of any heat engine, and explained the sequence, or cycle, of operations by which to secure the maximum efficiency of an engine working between two given temperatures. The inference is frequently made that, the nearer a given cycle can be made to the Carnot cycle, the greater its possible efficiency will be, and the phraseology of the subject lends itself to this fallacy. Now, if any simple gas engine were modified by the substitution of isothermic combustion, its actual thermic efficiency would be enormously decreased, and, conversely, the isothermic expansion of the Diesel Motor Cycle is far from being its most valuable feature.



SINGLE-CYLINDER NASH GAS ENGINE.



20-H.P. GAS ENGINE, NASH SYSTEM, DIRECT-CONNECTED TO RIKER DYNAMO.

After a given compression, we have the choice of three modes of combustion :

- (1) at constant volume, as in the Otto, or Beau de Rochas.
- (2) at constant pressure, as in Brayton's engine.
- (3) at constant temperature, as in the Diesel.

These are written in the order of their efficiency, and the " Rational Heat Motor " will be most efficient as a plain gas engine.

The illustrations, as already mentioned, represent characteristic American gas engines. Examples of the British type were illustrated in the January number of this magazine, and there appears to be a reaction in its favor in the United States, which adopted the lighter, more graceful, but less substantial German design.

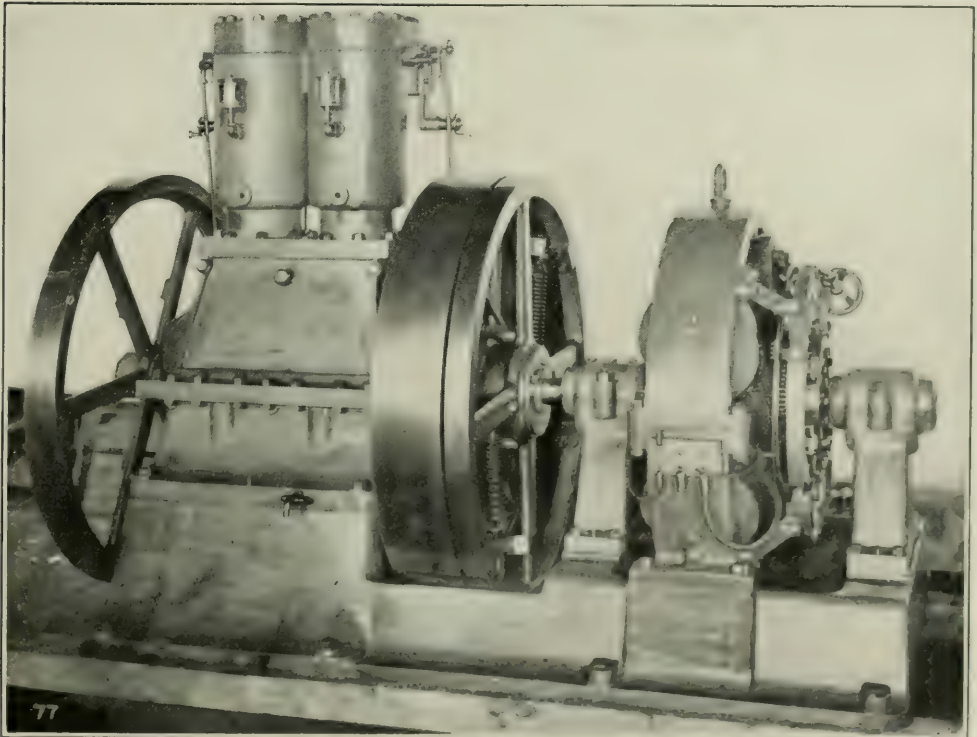
The details in each case have been worked out with great skill. For the ignition of the charge the Nash engine employs either the hot tube, or the electric spark, or both. The Westinghouse employs only the spark, but supplies each cylinder with a duplicate apparatus. This recognition of the element of uncertainty in artificial ignition emphasizes the desirability of abolishing it altogether.

The Westinghouse engine governs by throttling the charge, while maintaining a constant composition of the mixture. The result of this is that at light loads, the compression being reduced, the efficiency of the engine is reduced, as explained above, but at the same time,

there being no misfires, the speed regulation is much closer than is possible by the hit-and-miss principle. This sacrifice of efficiency to close regulation indicates the intention of applying the engine chiefly to the generation of electricity.

Several examples of direct-connected engines and dynamos are given. The Nash combination, as shown, employs a very ingenious arrangement for converting irregular into regular rotation. The engine, of which the regulation is effected by the orthodox hit and-miss principle, runs permanently faster than the dynamo with which it is connected by frictional contact. If the speed of the dynamo increases, an arrangement equivalent to a fly-wheel governor relieves the grip of the shoes and allows more slip. When the springs and counterweight are nicely adjusted, the sensitive and prompt action of this arrangement is astonishing, and it can be criticised only on the score of its excessive ingenuity.

One result of this arrangement, which appears singular until the cause is known, is the circumstance that, as more lights are put on, the brighter and steadier they burn. A little consideration will show that, the greater the load, the tighter the grip, and therefore the greater speed (and voltage) to release it; moreover, with greater load there are fewer misfires, and therefore there is less variation for the frictional connection to take care of.



20-H.P. NASH GAS ENGINE WITH DYNAMO, SHOWING FRICTIONAL CONNECTION.

The Westinghouse two-cylinder engine has a provision for distributing the shock of the explosion by means of a spring connection (as shown) between the engine and dynamo. With the three-cylinder engine, however, the necessity for a flexible coupling is believed to be obviated, and, since this type also has its moving parts well balanced, it is preferred by the Westinghouse Company.

There is an evident determination to solve the problem of "direct connection" in some form or other. In the meantime the link belt, run slack, together with a fly wheel on the dynamo, offers a solution which is effective and will not be abandoned until the various substitutes have shown that the necessary sacrifice of simplicity is warranted by the results.

So far as the writer knows, no independent tests have been made public, with the exception of one at Stevens Institute last year on a Nash engine, according to which the quantity of gas consumed per brake horse power was 17.62 cubic feet, which is equivalent to a thermic efficiency of 20.6 at brake. For starting the larger engines the Westinghouse Company employs the reservoir of compressed air, but with the addition of a very neat automatic valve arrangement, by which one cylinder is run for a few revolutions as a compressed-air engine. The Case engine introduced a rather bold method of starting by firing a cartridge of rather slow-burning powder, converting the engine for the initial stroke into a gun.

Precisely why, in the present state of the art, so much money should be spent in getting out a new gas engine is not entirely clear. One reason, probably, is that the designer generally starts out with a great contempt for what he considers the clumsy and empirical methods of the gas engineer. The first \$10,000 is spent in imparting to him a few elementary ideas on the subject, the second in trying his revolutionizing modifications, the third in getting the engine to run as economically as others in the market.

Even scientific Germany does not appear to be exempt from this process. The first Diesel engine was built without a water jacket, compounding is even now being experimented with at great expense, and to these ancient and distinguished fallacies is added a third,—the isothermal combustion elaborated with a quasi-scientific and solemn minuteness intended to be admired rather than understood.

For quick returns no improvement has been made on the old combination of a fine model and a limited knowledge of the art to which it belongs, the latter being essential to enable the inventor to promise, with the force of personal conviction, the extravagant results necessary to induce capital to take the desired "flyers."

REVIEW ^{OF} THE ENGINEERING PRESS

The Efficiency of Built-Up Beams.

AMONG the papers recently presented before the American Institute of Mining Engineers is one of especial importance, by Professor Edgar Kidwell, upon the efficiency of built-up wooden beams. From the fact that the matter has been almost, if not quite, neglected, Professor Kidwell's investigation into the comparative strength of various kinds of built-up and solid beams may be considered as an original contribution to the literature of constructive engineering.

Wooden beams are likely to be used for a long time, even though iron and steel construction has become so widely extended; and the limitations naturally placed upon the sizes of single sticks make it necessary, in many cases, to build up large beams from several pieces. Until now, however, the leading authorities upon the subject have assumed that the strength of the compound structure was at least equal to that of the solid beam, ignoring the weakening effect of the joints, and disregarding the obvious differences in the various methods of keying and bolting.

The respect which technical writers have for authority is seen in the faithfulness with which they copy and re-copy from Tredgold, even so original a writer as Rankine preferring to follow the ancient precedents with apparently no attempt to verify the results by tests or comparison with practical results.

Professor Kidwell respectfully places all the previous authorities on one side, and proceeds to make new tests of the received methods of construction, as well as of some additional forms of joints, expressing the strength in the form of a percentage of the strength of a solid beam of the same dimensions loaded under the same conditions.

The results of these careful original tests show how erroneous was the old assumption that the strength of a built-up beam

attained nearly or quite that of a solid one, for the investigations revealed the fact that some forms which had been considered among the best gave efficiencies as low as 60 per cent., while other forms, often more easily made, gave efficiencies as high as 90 per cent.

A still greater difference was found between the deflections of built-up beams and those of solid ones; in fact, this is frequently a matter of more importance in construction than the absolute strength of rupture.

The best form of built-up beam, according to Professor Kidwell's researches, is what is known as the "joggled" beam, with iron wedge keys, or even with wooden keys. This form is better than any of the more elaborate framed and bolted beams which have heretofore been advocated.

"It seems clear from these tests that it is practically impossible to construct a built beam which shall be as strong as a solid beam of equally good material. The writer considers that the results of the tests warrant the conclusion that the keyed or joggled beam is by far the best form, as it surpasses all others, both in strength and stiffness. Oak, hickory, hornbeam, or dogwood keys will suffice for beams constructed of white pine, spruce, or other soft woods, but iron keys should be used for hard-wood beams. Wedge-shaped driving-keys are necessary in order to secure the most efficient beams, and the keys should be of iron if the maximum stiffness is desired. In the centre of the span a space equal to about one-quarter of the length of the beam should be left free of keys, bolts, etc. It will be noted that, whenever less space than this was allowed in the tests, the efficiency was low, because the fracture occurred in the fastenings. In particular cases it may be necessary to use some bolts within the space mentioned to prevent the compression side from crippling, but such bolts should be as few

in number and of as small a diameter as can possibly be permitted."

When these precautions are observed, and proper care is taken in the design of the beam, efficiencies as high as 75 to 80 per cent. can be obtained with the jogged beam, together with deflections within 150 to 125 per cent. of those found with solid beams, while, with double-wedge cast-iron keys, a stiffness equal to that of the solid beam has been secured.

Movable Dams.

THE use of movable dams in connection with river-navigation improvements is much more general in Europe than in the United States, such dams being especially used in France and Italy, but with the increased attention which is being given to the subject in America such dams will doubtless be more and more generally used.

A very full paper upon this subject has been presented before the American Society of Civil Engineers by Mr. B. F. Thomas, reviewing what has been done in Europe and America, and practically constituting a complete review of the subject.

"The purpose of movable dams is to conserve the water in a stream during the season of medium flow, so that navigation may go on uninterruptedly through the lock, and restore the stream to its natural condition again (by lowering the dams) upon the approach of sufficient water for free navigation."

It is this important feature of adaptability to the condition of flow which gives the movable dam its great advantage over a fixed one, since it is often quite as important to provide for the excess of flow during the full season as it is to retain the water when the flow is insufficient to maintain a full channel.

"Another advantage they possess over fixed dams, which, however, seems to have been lost sight of, is that they are applicable to higher lifts, because they do not raise the level of the water during freshets above its accustomed height in the original condition of the river."

It is this point upon which Mr. Thomas lays especial stress, and he shows that the principal objection to movable dams, as at

present constructed, lies in the fact that the lift attained is too small to justify the expense. The success of movable dams cannot be considered complete, until they have been applied to lifts at least equal to those which would be given to fixed dams at the points, and at no greater cost.

There are two general classes of movable dams,—those requiring extraneous power for their manœuvring, and those operated by the force of the water itself,—and of these main divisions many varieties have been made. In the first class belong the various types of trestle and wicket dams, and the so-called "needle" dam, while in the second are included the several forms of bear-trap, drum wicket, and similar constructions. The needle dam, which has been much used in various parts of Europe, operates by damming the water up by planks, called needles, which rest against bars connecting the fixed trestles at the top, and against a sill in the river-bed. The needles are generally of small dimensions, and are operated by hand from a walk-way which passes across on the tops of the trestles.

Dams of the bear-trap and drum types have not been employed to any great extent on navigable rivers, and the most important feature of Mr. Thomas's paper is the description of the high needle dam at Louisa, Kentucky, on the Big Sandy river.

This important work, designed and constructed under the supervision of a commission of government engineers, is described at length, and is of especial interest because of the unusual height for a dam of this type, the needles being more than fourteen feet long, and the details of the trestles and apparatus for manœuvring being arranged with a special view to the safety and convenience of the men employed.

The method of operation can be described here only briefly, but photographs and drawings in the original paper give an excellent idea of the operations. The trestles, which are built up of steel channels, are so hinged to the sill that they can be laid flat across the bed of the stream, each nesting into its neighbor so that a

flat uniform bed is formed when the dam is down. This offers the least possible obstruction to the water, and prevents the lodgment of drift and possible injury to the works in time of freshet. The needles themselves are placed in position from a boat above the dam, and, owing to the size and weight of the needles, a power crane swinging from the bow of the flat boat furnishes the necessary power to place them rapidly and accurately in position.

Ordinarily the needles can be removed in a similar manner, as the gradual increase in the flow gives warning, but, when it is necessary that the dam be opened promptly, as in times of sudden rise, an arrangement of chain connections enables the needles to be removed in rapid succession, and with entire safety, by power from the shore. The trestles are raised and lowered by chain connecting to winding crabs on the piers and lock walls.

The experience thus far gained with this dam confirms the correctness of the view upon which its construction was based, and demonstrates that a high needle dam can be built and operated with success and safety.

Mr. Thomas's paper contains a full review of a great number of proposed and executed movable dams of many designs in various countries, and for this reason, as well as for the account of the Big Sandy dam, it will be accepted as a valuable contribution to a branch of engineering which has hardly received the attention which its importance deserves.

Aluminum for Electrical Conductors.

SINCE the rapid modern development of methods for the cheap production of metallic aluminum, the manufacturers have endeavored to find new applications for it, especially in lines which will absorb a large output and increase the demand.

Among the possible uses of aluminum, that of a substitute for copper for electrical conductors has been suggested by Mr. Alfred E. Hunt, whose share in the development of the commercial production is well known by all. Mr. Hunt, in a paper published in the *Electrical World*, gives some interesting comparative figures between

the electrical conductivity of copper and aluminum, and shows that the conductivity of aluminum is about 63 per cent. of that of copper, while the weight of copper is 3.33 times that of an equal volume of aluminum. From this it follows that, even when the cross-section of an aluminum conductor is increased enough to give an equal conductivity, the weight will still be only about 48 per cent. of that of a copper conductor.

"To obtain, therefore, a conductor of aluminum at the same cost of metal per ohm per mile, the cost per pound of the aluminum may be about 2.1 times that of the copper; assuming the cost of the copper at 14 cents per pound, it is evident that aluminum at 29 cents per pound is slightly cheaper than copper."

In regard to the question of tensile strength, it is stated that aluminum wire can be furnished of the same tensile strength, per unit of area, as annealed copper wire,—say, about 32,000 pounds per square inch of cross-section,—but, as the aluminum wire is of greater area, the actual strength is greater in proportion.

It is practicable to produce alloys of aluminum of much greater strength than that above given, but their conductivity is less than that of the pure metal, although the prediction is made that an alloy can be made with a tensile strength of at least 65,000 pounds and a conductivity of more than 50 on the Matthiessen scale.

One objection which is urged against aluminum for this purpose is the difficulty of soldering, or brazing, the metal. It is possible to make a good soldered joint, but the operation is slow and difficult, and the galvanic action between the aluminum and the metals of the solder is much greater than between copper and the metals of the solder; hence the joint weakens more rapidly. Probably better success will be had by the use of mechanical joints.

Aluminum has been successfully used as an electrical conductor for several years, both at the Niagara Falls works of the Pittsburg Reduction Company and in a telephone line at the Chicago stock yards with satisfactory results as regards both conductivity and resistance to corrosion.

The Sanitary Arrangements of Hospitals.

SANITARY plumbing is now recognized as a most important factor of public health almost everywhere, but there is probably no place in which care in this respect is more important than in hospital buildings, where large numbers of disabled and diseased persons are gathered in confined areas.

A paper by Mr. William Paul Gerhard, published in the *Albany Medical Annals* treats in a very thorough manner of the plumbing, water-supply, and drainage of hospitals, and contains much that is of value and importance to architects and engineers whose work falls within this department of construction.

It is impossible to do more than indicate the points which are treated by Mr. Gerhard, and, for a fuller discussion, reference must be had to the original paper; but the principal features of the subject may be noted briefly here.

In regard to sewage disposal, it is wisely recommended that, even where the sewage is discharged into city drains, it is best to provide some means for purification, and at least to intercept all solid matter, paper, rags, etc., while, where city sewers are available, some method of sewage filtration through natural or artificial sand and gravel beds is recommended.

Abundant water-supply is a point strongly emphasized, fifty gallons per head per day being given as the minimum, while as much as two hundred gallons is the average daily consumption in some of the State hospitals. Mr. Gerhard naively recommends lavish use of water when it is freely supplied by city water works, but counsels economy when it is pumped at the expense of the hospital treasury. Purity of water-supply is naturally insisted upon, and a constant watch kept to detect subsequent pollution.

Some excellent hints are given in regard to plumbing details, and, while in general these are such as also apply to private houses, there are some features especially necessary for hospital service. The plumbing should be arranged in vertical groups, and rooms containing plumbing should never be entered from the wards directly,

this point being especially imperative in the case of surgical wards. All plumbing should be separately trapped, and care taken that the traps may not lose their water seals, this object being effectively attained by using deep water seals for the water-closets, and non-siphoning water-seal traps under the other fixtures. Long branch wastes must in all cases be extended separately up to the roof, but the traps under the branches do not need a back air pipe. All plumbing arrangements should be as simple and direct as possible, and no encasing in woodwork or concealing of details anywhere should be permitted, everything being made perfectly accessible and in evidence.

Bath-rooms and lavatories should be arranged so that they can be washed down with hose, both walls and floors being finished with waterproof non-absorbent material, such as enameled brick, slate, or marble for the walls; and concrete cement, or tiles for the floors. In some modern hospitals spray baths are used entirely, and tubs have been altogether abolished; this method is recommended as simpler and better than the old system.

The lavatory arrangements for the hospital staff, including bath-rooms, should be entirely separate from the accommodations for the patients, and the operating rooms and clinical theatres must, of course, be constructed according to all the requirements of modern aseptic surgery. Kitchen attachments do not differ greatly from those for good hotel service, except in the greater care for an abundant supply of water, air, and light, and ample provision for cleanliness.

Good work, however, is only a part of the problem; capable, skilled supervision must be employed to keep even the best arrangements from deteriorating. As Mr. Gerhard well concludes:

"In a well-managed hospital the most thorough cleanliness and a pure condition of the air indoors are secured by constant vigilance against all manner of dirt. Half the battle is won where the buildings have a good system of sewerage and plumbing. These will not only prevent a contamination of the atmosphere in the toilet rooms,

laboratories, and sick wards by emanations from the sewer pipes and plumbing fixtures, but they will also render it impossible for the soil upon which the building stands to become polluted and give off gases injurious to health and fatal in disease. They will finally assist in the maintenance of absolute cleanliness of the walls and floors, of a personal cleanliness, and purity of the water- and food-supply of a hospital."

These points, and many others which are discussed in the paper, and which are of most importance at the critical time when the original plans of a hospital are being prepared and executed, should not be left to architect, builder, and building committee alone; the services of a competent hydraulic and sanitary engineer should be secured at an early stage, for, even in the selection of a hospital site, questions of drainage and water-supply may and will arise, which can be decided best by the thorough knowledge and practical experience of a specialist.

Canals for Large Traffic.

WE have already referred to the report of Major Symonds upon the advisability of constructing a ship canal from the great lakes to the Atlantic, showing that in his view the returns from such an enterprise are hardly likely to warrant the great outlay necessary. The other side of the question is discussed at length in a paper read before the American Society of Civil Engineers by Mr. Joseph Mayer, and it is probable that, by a comparison of these two views of this important matter, a safe and satisfactory judgment may be reached.

Mr. Mayer logically treats the subject as consisting of two opposing elements of cost. "There are," he says, "two kinds of cost incurred in moving freight,—cost of transport and cost of transfer. The best possible adaptation of the carrier to the route on which it travels will make the cost of transport the smallest. Canals of moderate depth will furnish very cheap transport, if the carriers are especially adapted to them. This best adaptation of the carrier to the route, for the traffic between the lakes and Europe, is, however,

only obtainable by transfers in New York and Buffalo. These produce large costs of transfer and slowness of transportation,—the latter a disadvantage difficult to be expressed in figures, unless the higher freight rates and larger amounts of business which the railroads are able to obtain are taken as a measure of it. These costs of transfers can, on the route there considered, be partly avoided by using barges that are able to run safely and economically on the lakes and sea-coast. These barges, however, are not as economical on canals as mere canal barges, because the latter can be built much lighter. These lake barges need also a much deeper and more expensive canal. All transfer costs of through freight, and consequent delays, are avoided by a canal accommodating ocean steamers."

Taking these opposing elements into account, Mr. Mayer proceeds to discuss the relative advantages and disadvantages of canals of various depths, with the idea of determining the economic depth in view of the commercial conditions existing.

Taking successively into consideration canals of 12, 18, 24, and 28 feet in depth, with the attendant costs of deepening lake and harbor channels, and opposing the various costs for transport and transfer for the probable amount of traffic, fairly definite conclusions may be drawn for various distributions of the traffic.

On the assumption that the freight would be about equally divided between New York, points near the sea-coast, and European ports, the saving on an 18-foot canal, as against the present Erie canal, is estimated by Mr. Mayer at an average of \$1.42 per ton. This estimate contemplates the use of barges which, while suited for coast delivery, would not cross the ocean. It is probable, however, that ocean-going barges could and would be designed for use on the lake, should a canal of 18 or 20 feet in depth be built between Buffalo and New York.

The advantages which attach to the use of large motorless barges are pointed out at some length, and the great economy in proportion to carrying capacity is empha-

sized. Motorless barges can be hauled by powerful tugs at the speed of lake vessels, when on the lakes or sea-coast, and, when in the canal, by small tugs. Large motorless lake or ocean-going barges, therefore, fulfil most nearly the conditions for speediest and cheapest transport,—namely, absence of transfers and best adaptation of carrier to route.

A marked gain in time in such a canal as is here considered would be effected by the substitution of some form of mechanical lock,—such, for instance, as Dutton's pneumatic lock—for the lock systems now at Niagara Falls and Cohoes, one or two drops taking the place of a series of common locks, with their accompanying delays and inconveniences.

Mr. Mayer does not claim to have settled the subject definitely from his point of view, and admits that no calculations and inferences can be more reliable than the data on which they are based; in closing, he states that the question can be settled only by carefully analysing the cost of transportation, separating it quantitatively into its different elements, finding how these elements are affected by different kinds of canals and carriers, and then choosing that combination which will make the sum of all the elements of cost a minimum.

Hydraulic Rams.

THE hydraulic ram is so simple and well-known that it seems as if all that ought to be known about it should have been put upon record long ago; but, when one comes to look up authoritative and reliable data concerning performance and efficiency, the meagre nature of our information becomes apparent. It is, therefore, a matter of interest to find a paper upon the subject presented by so well-known an engineer as Mr. John Richards before the Technical Society of the Pacific Coast, and published in the *Journal of the Association of Engineering Societies*.

Although invented more than one hundred and twenty years ago, the hydraulic ram has not improved as rapidly in the United States as have other forms of machinery, but, rather, has degenerated into

a sort of staple article, like hardware, with a continual effort toward cheapness, so that the rams now made in America are distinctly behind those of European makers in design, efficiency, certainty of action, and especially in devices for use against high pressures. These points may be clearly shown by comparing illustrations of rams made in the United States with illustrations of those of English, Swiss, French, and German builders. The European machines cost four to five times as much as those offered in America.

On the subject of the literature of the hydraulic ram, Mr. Richards says truly that it is scant and of bad quality, and has never lent much aid to those engaged in their construction. The theoretical and computable elements involved in the action of hydraulic rams are simple, so far as the principal forces are concerned, but the conditions and phenomena of their action—in the case of small rams, at least—have made it necessary to base all rules on observed, instead of computed, results. The various engineering hand-books give but little information, and that little has been copied and recopied from the theoretical discussion of General Morin, and from the papers of d'Aubuisson and Eytelwein, with but little regard to the actual performance of machines in daily work. Even so careful an authority as Molesworth gives a number of antiquated rules, in which the efficiency is involved with the ratio of lift to the supply-head, whereas, as a matter of fact, if the machine is properly proportioned to the work it has to perform, the efficiency should be uniform, or nearly so, for all heads within common practice,—with a limitation, hitherto neglected, based upon the resistance offered by the inertia of the water resting on the check valves.

The most important feature brought out in Mr. Richards's paper is the fact that the so-called "ramming" action of the escape valve is not only objectionable, but also unnecessary and undesirable. As a matter of fact, this concussive action has nothing to do with the performance of the ram, and is destructive and without purpose. Mr. Richards himself has designed rams

with valves which are operated by the reaction of the escaping water instead of its impingement; these operate much better than the older form, but the highest efficiencies have been attained by the Pear-sall machine, and by a still later form of Mr. Richards's design, in which the waste valves are operated mechanically. A very simple and effective form of such a ram is one in which a small overshot wheel, operated by a little stream of water from the supply-head, operates a cylindrical intermittent waste valve with a periodicity entirely under control, and altogether independent of the action of the water itself. It is also thus possible to make the valve so quick-closing as greatly to reduce the usual waste at this point, and, as the volume of water that escapes after the waste valve begins to close is from 15 to 25 per cent. in rams of the ordinary form, the economy of this improvement is evident.

As a result of his general analysis of the subject, Mr. Richards suggests that, for small rams, it is advisable to subdivide the escape valves, and increase their number, thus keeping the range and time of closing down to that required for one small valve.

For rams of larger sizes, grid or multiported valves are recommended, or, for the largest rams, with inlets exceeding 12 inches in diameter, rotary lantern valves; the operation in either case is mechanical, an ante-compression chamber being employed to avoid concussive action.

The Diesel Motor in America.

WE noticed very fully in these columns the notable advance in internal-combustion motors made by Herr Rudolf Diesel promptly upon the presentation of his original paper before the convention of mechanical engineers at Cassel, in June of last year; and since then many accounts of the Diesel motor have appeared in the technical press in Europe and America,

Probably the fullest presentation of the subject—apart from a translation of the original paper in the columns of the *Progressive Age*,—that has been made in the United States was a paper read before the Engineers' Club of St. Louis by Colonel

E. D. Meier, who has had the opportunity of investigating the motor in Germany, and who is especially competent to discuss it from the standpoint of the specialist in power generation.

"Ignoring for the moment the patented details of the engine itself, Diesel's main invention is a *process* for converting the heat energy of fuel into work. It consists in first compressing air, or a mixture of air and neutral gas or vapor, to a degree producing a temperature above the igniting-point of the fuel to be consumed; then gradually introducing the fuel for combustion into the compressed air, while expanding against a resistance sufficient to prevent an essential increase of temperature and pressure; then discontinuing the supply of fuel, and further expanding without transfer of heat. This is, then, a process embodying in part the best of our steam-engine methods. But Diesel, by using only permanent gases for the vehicle of the expansive force of heat, avoids cylinder condensation. He has less loss of heat to the cylinder walls, because these gases have less conducting power than steam. The compression before admission, which we find so essential to the smooth working of the steam engine, he uses to a far greater extent. In fact, his upper limit of pressure is reached by the compression itself. Even the combustion does not essentially increase his temperature or pressure, since it does mechanical work during its entire continuance, and, after that, during expansion.

"The sudden blow on the piston, which occurs even in the steam engine, and is unchecked and violent in all previous internal-combustion motors, is entirely avoided by Diesel, for his adiabatic compression is gradual and complete. In place of the 30-per-cent. of clearance in previous gas and oil engines, he has less than 7, and this small space is filled with air compressed to over 500 pounds' pressure and at a temperature of over 1,000 degrees.

"Into this the petroleum is slowly and gradually injected during a predetermined part of the stroke by means of compressed air, compressed by a separate air-pump to

a temperature higher than that in the working cylinder. The result is a gradual and complete combustion, so that the exhaust of spent gases is noiseless, odorless, and invisible."

Comparisons of cost show that with the Diesel motor with Illinois coal at \$1.10, the fuel cost alone, for 100 h. p., is about 62 per cent. of what it is with a Corliss engine of the same capacity. With eastern coal of better grade,—taking into account the superior steaming power,—at a price of \$2.80 per ton, the fuel cost with the Diesel motor is only 35 per cent. of the fuel cost with the Corliss engine, fuel oil being taken at 2 cents per gallon in both cases.

The manufacture of the motor has already been taken up on a large scale, shops in France, Germany, Belgium, Switzerland, Denmark, and England having been licensed to build the new engine; and it is understood that the United States is also to be included in the list. In conclusion, the question whether the Diesel motor will supersede the steam engine in time is seriously discussed. "Certainly our European colleagues believe that it will. In America, of course, the conditions are different. Our fuel is cheaper and more abundant, and we are less inclined to economize in that item. But our labor is much higher, and, as the labor account shows a large balance in favor of the Diesel motor, I see no reason why, with the natural development of type after type, the Diesel motor will not obtain the lion's share of the work now done by the steam engine."

A Large Filtration Plant.

IN many cities the problem of pure water is exciting much attention, and, in view of the limited control of river sources, the question of purifying river water by filtration has received consideration in many places.

At Lawrence, Mass., a sand filter plant with a capacity of 5,000,000 gallons has been installed, this being the largest sand-filtration system in the United States, while at Wilkes-Barre, Pa., is a mechanical filter plant of double the capacity; but both of these will be excelled by the

sedimentation and sand-filtration system about to be constructed at Albany, N. Y., and to have a capacity of 15,000,000 gallons per day.

From a description in *Engineering News*, based upon the plans and specifications of Mr. Allen Hazen, the following points are obtained.

The work includes a sedimentation chamber of a capacity of 16,000,000 gallons; eight masonry-covered filter beds, with an available area of about 0.7 acre each, and a total daily capacity of 15,000,000 gallons, but expected to work at a lower average rate; a masonry-covered pure-water reservoir, with a capacity of 600,000 gallons; and all necessary appurtenances for a complete water-purification plant, including devices for aerating the water before sedimentation, regulators to control the rate of filtration, a bacteriological laboratory, and sand-washing apparatus.

Formerly the water-supply of Albany was effected entirely by gravity from a number of small streams, but, as this became insufficient, pumping from the Hudson was resorted to; and, as the intake was near the heart of the city and sewage discharge entered the river at higher points, the result was anything but healthful or safe.

The new plans include a change of location to a point further up the river, where the water will be pumped to the sedimentation basin, and, after filtration, will be delivered by gravity from the pure-water reservoir to the present pumping station.

The delivery to the sedimentation basin is made from the pumping-main through inlet pipes pierced with small holes, dividing the water into small jets and affording sufficient aeration. From the sedimentation basin the water flows to the filter beds, the inlets being at the corners of each bed; after filtering through four feet of sand and one foot of gravel, it passes into vitrified salt-glazed pipes, laid with open joints to admit the flow and conduct it to the reservoir.

The filter beds are to be covered with groined arch vaulting of concrete, with concrete floors and clay puddle beneath.

THE BRITISH PRESS

Engines for Electric Traction.

AT the annual meeting of the Institution of Mechanical Engineers there was an animated discussion on the subject of engines for electric traction, there being material difference of opinion as to the best type of engine for this service. While the principal feature of difference appeared to be that of long-stroke slow rotative speed as against short-stroke high speed, it might more properly be described as relating to the effect of sudden changes of load upon the engine itself.

The extent to which American precedents in electric traction are to be considered as applicable to English conditions was the subject of much of the discussion. In the United States, where electric traction has been in use for more than ten years, the use of short-stroke high-speed engines has largely been abandoned in the great power houses, and larger long-stroke condensing engines adopted, using heavy fly-wheels and governors adapted for the fluctuating loads. In England the present tendency, at what is almost the introductory period of experience in electric traction, is towards the use of light, quick-running engines, of which the Willans engine may be considered a typical example, and in which the division of the effort around three points of the circle permits the use of light fly-wheels, while attaining close regulation with varying loads.

There is no doubt that, when all the points are taken into account, either system may be made to answer perfectly, and it is only when attempts are made to apply engines to work for which they are obviously unfit that unsatisfactory results will follow. The Willans engines used at Liège have proved well adapted for tramway service, but so have the many installations of long-stroke Corliss engine in the United States. There is no doubt that a high rotative speed permits a much lighter fly-wheel, and that prompt and efficient governing can be attained in a form of

engine which is in effective connection with the governor more frequently in the same space of time than is the case with the slower engine.

The real reason why the large, slow-speed engines have come into so general use in the United States is that they are more economical in the matter of steam than the quick-running single automatic engines which for a time had such vogue in electric lighting and power stations.

Among the engineers who took part in the discussion, several had had personal experience of existing practice in America, among whom may be noted Mr. Jeremiah Head, Professor Unwin, Mr. Holroyd Smith, and others; while these experienced engineers were not disposed to affirm the entire adaptability of American practice to British conditions, they were inclined to think that the results of ten years' experience over thousands of miles of tramway were not lightly to be cast aside. As Professor Unwin put it: "The American engineers might, or might not be wrong; but what they had done was the result of actual experience, and for this reason was of more value than seemed to be attributed to it."

As a matter of fact, there is no reason why an electric-power plant should be treated in a different manner from any other power plant; each case should be considered in view of the especial conditions obtaining. This was clearly set forth by Professor Kennedy, who warned engineers against taking a partisan view of the merits of high- and low-speed engines. He thought the whole subject should be considered as a problem in mechanical engineering, taking into account the merits on both sides. The introduction of electrical traction in England will be effected more advantageously because of the experiences of those countries which were earlier in the field, considered in the light of the different conditions which naturally exist.

Improvements in Transport Facilities.

IN his presidential address before the Society of Engineers, Mr. W. Worby Beaumont discussed a number of interesting features in connection with possible improvements in the application and use of mechanical motive power, principally from the point of view of a critic of a conservatism which permits the wasteful methods of power use now in vogue to continue.

We see this conservatism in mills where antiquated engines, badly-balanced shafting, and impure boiler-feed water are daily wasting money which could readily be saved, or rather used; we see it in collieries where badly-prepared coal is sold at unnecessarily low prices for lack of proper care; and, most of all, we see it in the enormous waste of time and money by the use all over the country of double the horse power that would be necessary for cartage if anything but antiquated notions prevailed as to the construction and maintenance of roads and of the vehicles that run upon them.

Taking up the subject of horse hauling, Mr. Beaumont estimates that there are about 1,500,000 horses in the United Kingdom, and that, by small improvements upon the present methods of constructing and maintaining road-surfaces, at least one-tenth of these could be dispensed with. In order to be on the safe side, however, he makes his computation upon 500,000 horses. To save only one-tenth of this number of horses would mean a saving of £1,500,000 a year, and all the other 450,000 horses would be able to earn from 5 to 10 per cent. per year more than at present. Taking it at 5 per cent. year, the saving on this head would be £2,250,000 per year, or a total of £3,750,000, which, capitalized at 3 per cent., represents a principal of £125,000,000, so that at least £100,000,000 might profitably be invested in the improvements of the highways.

Improvement of roads would lead to the general use of motor vehicles; on this point, as might be expected, Mr. Beaumont is especially emphatic.

"If we are to have the advantages of cheap and rapid transit between the hard and fast points of railway service, we must

have mechanical power on the roads. Already the importance of this is recognized, but it is necessary to point out that, to secure the greatest possible advantages of this, we must have not only the mechanically-propelled vehicles, and the roads suitable for their working, but that these very road improvements are as desirable for the horse-propelled vehicles.

"Over many miles of suburban and country roads the construction of really well-made macadam roads, with wheelways at the sides, will make a splendid national investment. The better the road, the longer it lasts, the less the time lost by stoppages of traffic for heavy repairs, the greater the average speed of goods and passengers.

"The haulage-resistance on well-finished macadam roads is less than half that on a badly-made road of the same kind. This means more than the fact that one horse would do the work now done by two, and do it quicker. With the improvement of the worst gradient one horse could, in many parts, do the work now done by three, for it happens frequently that the full power of the two or three horses of the team is only required for a fraction of the whole road traversed. Further than this, it means that the mechanically-propelled vehicle could do with either less than half the steam engine power now necessary, or could carry greater loads, and the average speed would be greatly increased without making any addition to the full speed. In fact, the maximum speed could be reduced, and a higher average speed attained. With the improved roads the cost of fuel, either as horse feed or as coal or oil, would be enormously reduced, especially in the case of horses, and the distance traversed by mechanical road vehicles with one supply of fuel and water would be proportionally increased."

"Now, I believe improvement of our common roads to suit the possibilities of mechanically-propelled vehicles, and the design of the vehicles to suit the possibilities of high roads, will, in the future, make a change almost as vast as that which has been wrought by the mechani

cal horse on iron roads. We have our roads leading from everywhere we want to go or send goods to our houses and factories. We want to take advantage of the powers which the steam engine will place in our hands if we will but give a fraction of the ingenuity to the construction of roads which we have given to the construction of this world-changing motor."

"On the road-construction and -maintenance of the future depends the development, not only of the machinery required for the purpose, but of high-class self-propelled vehicles for every application; and on the improvement of road communication between towns and villages depend not only great engineering industries, but the growth in the value of land."

Hydraulic Jointing.

THE customary method of joining the tubular portions of bicycle frames to the intermediate connecting parts is the time-honored process of brazing; but recently a method of expanding the tubes by internal hydraulic pressure has been devised, and, by the use of powerful special machinery, some effective work has been accomplished. From an account of the Crowden system given in the *Engineer*, the process, and the machines used in connection with it, may readily be understood.

The sockets at the crank-hanger, front-swivel, and seat are made with grooves on the inside, these grooves being given the form of a double helix, in order effectually to resist the twisting stresses; and, when a pressure of seven tons per square inch is exerted upon the inside of the tubing, it is expanded into these grooves in a manner that insures a very strong union and connection. Such a pressure naturally tends to enlarge the entire tube, however; hence, some method is necessary to prevent the tube from expanding anywhere except in the sockets where the joints are to be made. This support for the tubing is provided by special jigs, or frames of great strength, carrying dies which surround and support the tubes and sockets on the outside, the jigs being made in halves so as to admit the frames readily,

and the dies of various sizes and shapes to admit different kinds of bicycle frames.

Much ingenuity has been expended upon the details of the special machines, these being largely due to Mr. Johnson, by whom the process is operated; and the succession of operations has been so thoroughly worked out that, it is claimed, the entire process of making all the joints in a frame occupies only about three minutes.

The use of expanded pipe joints is well known in steam-boiler practice, and is there found to be perfectly satisfactory, and there appears to be no good reason why a similar method should not work well in bicycle construction. The conditions of use, however, are so different in the two instances that only the test of practical hard usage for a considerable period of time can determine whether the system will stand the jarring vibration and lower factor of safety. If the permanent strength of the joint is demonstrated, and no tendency to work loose is developed, the method should come into extensive use, as all heating of the steel is avoided and a material saving in time and labour effected.

Power from Furnace Gases.

WE have already referred in these pages to the attempts made in various places to use the discharge gases of blast furnaces in internal combustion motors as a direct source of motive power, instead of adopting the less direct plan of burning them under boilers for the generation of steam. An excellent measure of success has been attained in this direction in Belgium, and now we have information of similar experiments in Scotland.

A paper by Mr. William Galbraith in the *Colliery Guardian* gives a detailed account of the tests at Wishaw, near Glasgow, adding some valuable experimental data to the information already available. Mr. Galbraith shows that the coal burned in a furnace making 300 tons of iron per week produces gas sufficient to generate nearly 1,800 h. p. on a basis of 4 pounds per horse power per hour, which gives an idea of the enormous amount of power

passing unutilized from the tops of our furnaces.

The plant at Wishaw consists of an Acme gas engine, capable of developing 30 brake horse power with Glasgow gas, the cylinder being 12 by 20 inches, with a Thwaite plant, consisting of a small coke scrubber, a physical purifier, gasholder, small fan, etc., and is connected to a compound-wound dynamo, the whole at present being used only for lighting purposes.

A number of careful tests were made with this plant, using gases from the blast furnace, with the result that about 15 h. p. was developed by the consumption of about 90 cubic feet of gas per horse power. The analyses of the gases showed that the effective constituents were present in about the following proportions: 26 per cent. of carbonic oxide, 2 per cent. of methane, and less than 1 per cent. of hydrogen, the thermal value running about 135 B. T. U. per cubic foot. One pound of coal yielding about 58 cubic feet of gas, 1.54 pounds of coal are needed per horse power.

"It is clear that the gas, being different and much poorer in combustible gases than the ordinary retort gas, would not develop the same power in the gas engine; and, as the latter was, of course, designed to use retort gas, certain modifications had to be carried out on the engine. With the exception that the engine is rather over loaded, or, rather, that sufficient margin had not been allowed for the difference in the explosive power of the gases, these modifications, which were not of a serious character, proved entirely successful, and for many months the engine did its work with as little trouble as the steam engine which it replaced."

Subsequently certain irregularities in ignition appeared, and an investigation by Prof. Rowden developed points interesting to those who are attempting to use blast-furnace gases for motive power. Owing to the poor nature of the gas, the spread of the flame from the point of ignition was much more sluggish than with the richer illuminating gas for which the engine was originally designed. The ignition was effected by the uncovering of an

incandescent tube by a timing valve, but the slow response of the furnace gases rendered this method of regulation of lead uncertain. By providing a larger and quicker opening valve, a much better ignition was effected, and the action of the engine was made as certain and effective as with the illuminating gas, the only difference being in the reduced power, due to the poorer quality of the gas.

Altogether, the results of this experience at Wishaw are most encouraging, especially because they were achieved by a plant actually in operation rather than by a brief experimental test.

Prof. Rowden does not hesitate to express his favorable opinion of the practice of using furnace gas, and says: "My observations lead me to think that the gas from the Wishaw blast furnaces is superior in quality, and more uniform in composition than the average gas from a Dowson producer."

The Care of Steam Boilers.

NOTWITHSTANDING the great advances which have been made in the construction and operation of steam boilers, it is still true that in many important locations this important feature of every steam plant is often sadly neglected. A leading article in *Engineering* discusses this subject in a forcible manner, and brings out clearly the weak points in steam boiler operation and the care which should be given to keep a good boiler in proper working order. Many of the facts about the neglect to which boilers are subjected would hardly be believed, if they were not obtained from the evidence brought out in the board of trade reports upon boiler explosions, but investigations after explosions may at least assist in preventing other disasters, and all such information should be given a prominence which the importance of the subject demands.

"Whether an owner ought to place his boiler under the charge of some inspecting company, or not, of course depends to a certain extent on special circumstances. If an owner has in his employ, or can command the services of, a thoroughly competent man, whose duty it is to periodically

examine the boiler, and who has power to have all necessary repairs carried out, he being made responsible that such repairs are carried out, then such outside inspection may be dispensed with, although even in such cases the extra security given by an independent inspection is well worth its very moderate cost. Where, however, the conditions just named are wanting, the periodical inspection of the boiler by a competent inspecting company is an absolute necessity."

The two great enemies of steam boilers are corrosion and incrustation; corrosion because of its direct reduction of the strength of the metal, and incrustation because of its indirect influence in causing overheating. A third source, similar in effect to incrustation, but differing widely in nature, is the accumulation of coatings and deposits of grease upon the surfaces of the boiler, this being a frequent cause of injurious overheating. The increasing use of surface condensers, and the feeding of the greasy condensed steam into the boilers, are undoubtedly responsible for many collapsed flues and burned crown sheets. An entirely satisfactory method of freeing condensed steam from the cylinder lubricant has not yet been devised, although numerous filtering devices are made which partially accomplish the result. The presence of oil in the boiler is especially objectionable when the water contains lime, as the combination forms a spongy mass, which is a very bad conductor of heat.

Theories of corrosion based upon electrolytic action appear to have lost ground of late, although there is still much difference of opinion on that score. The efficacy of zinc in boilers as a preventive of corrosion is still accepted by some who are well qualified to speak, but the exact nature of its action, as well as the separation of such action from that due to other causes, is still unsettled.

Very pure waters often exhibit a very active corrosive effect upon boilers, and this action can be explained only upon the assumption that it is caused by the liberation of the oxygen and carbonic acid dissolved in the water. Waters containing

gases are also objectionable from the persistence with which the bubbles of separated gas cling to the metallic surfaces, permitting overheating, and hastening corrosive action. It is probably this separation of corrosive gases which causes the pitting of feed-water heater tubes, and makes the use of brass or copper tubes necessary.

"The best remedies for corrosion are generally the simplest and least expensive; but, after all, there can be no hard and fast rule laid down as to what should and what should not be used, as so much depends on the water, the kind of boiler, the conditions of work, and many other things. Perhaps two of the simplest remedies ever used as a safeguard against incrustation are petroleum and common soda; but even these must be used with care, and in the proper proportions; else the evils that they cure may be less than those they bring about; and it all comes back to what we said before,—that steam-users should have some competent man to advise them, be he the engineer to a boiler inspection company, or any one else capable of giving sound advice on the subject.

Engineering Appliances in Mining.

IN an interesting paper read before the Manchester Association of Engineers, and published in the *Colliery Guardian*, Dr. C. M. Percy reviews the relation of the work of the mechanical engineer to the operations of mining, and points out features worthy of careful consideration. Although the paper is practically confined to coal mining, much of the matter is general in character, and even the coal-mining industry is important enough to demand interested attention to this aspect of it.

The writer first reviews the progress made in the past generation in mechanical appliances in mines, especially the improvements in conveyance and ventilation. The systematic manner in which the underground conveyance from the furthest workings to the pit bottom is effected is one of the best pieces of mechanical engineering in mining work. In ventilation the immense increase in the volumes of air handled is a feature well worthy of

note. In an average colliery, working, say, 500 men underground, the quantity of air passed through the mine represents an actual weight of 500 tons per hour, and, as a matter of fact, the weight of air passing through a coal mine is enormously in excess of the total weight of coal and water and dirt and everything else raised, reaching thousands of tons each year for every individual miner.

The winding machinery of a mine is an important contribution of mechanical engineering to mine operation, and its action is a peculiar operation, in which a more than moderate efficiency is impossible. Each operation occupies less than a minute, and comprises, first, the starting from rest, accelerating to a speed of sixty miles an hour; second, running at that high speed for a few seconds; third, falling away to rest again. With this must be combined such control as shall render accidents practically impossible. The great improvements in the construction of winding ropes has added much to safety, and Dr. Percy holds that assurance of great strength in the ropes is the best precaution against accidents that can be taken,—better than the use of appliances to prevent injury after a rope has parted.

In discussing the lines of future improvement, Dr. Percy brings out some important points. Among these is the rather natural fact that at the coal mine, where fuel is plentiful, it is used in a most wasteful manner. Although there are no exact figures available, a close estimate shows that about 5 per cent. of all the coal mined is used in raising it to the surface, this including, of course, all the power used at the collieries for various purposes.

Taking this consumption in connection with the average depth of the pits, and computing the quantity of work performed, he concludes that, compared with the performance of the most economical modern engines, the steam machinery at the collieries uses about ten times as much coal as is required to generate the same amount of power in high-class mills and factories.

The pumping machinery used at the mines is not so wasteful, and many of the

pumping engines now used compare favorably in point of economy with pumping engines anywhere. The hauling machinery, to which reference has been made, is deficient mainly in that the limit of distance is too soon reached. When electrical transmission has been made absolutely safe, power will be transmitted to distant points by electricity rather than by compressed air. This is especially important in connection with the extension of the workings under the sea. Coal, several yards in thickness, is now being worked at a distance of three miles off the coast of Cumberland, and coal measures are known to exist under the sea on both the east and west coasts. By the use of electrical transmission, power could be delivered to such workings with little trouble.

In the introduction of coal-cutting machinery there is room for advance. "In very many cases coal-cutting machines could do good work, not so much in the direction of diminishing the actual cost of production, but by increasing the value of the product in lessening the waste. The pick of the collier is a very handy appliance, and is not likely to become an absolute relic of the past; but, although in the hands of an expert workman, it does good service, it is wasteful. What with shattering by high explosives and crushing with the pick, nearly one-half of the coal is sent to the bank as slack. The difficulty has been in the application of a suitable and convenient power by which the machines can be put to work anywhere and this power transmitted by a simple wire." If electricity is advanced to such an extent that it can be used to transmit power safely in coal mines, coal-cutting machines are likely to come into extensive use. At present, however, the sparks from which electric appliances are as yet not entirely free are too probable sources of gas ignition to be permitted in mines which contain even a small proportion of explosive gases. It is more than probable that electrical machinery for use in mines will soon be made entirely safe, and then, doubtless, the electric plant will be a part of every modern mine equipment.

Engineer and Architect.

A LATE issue of the *Building News* contains an article on the relations of the architect to the engineer which may be read with profit by both.

It is the scientific application of engineering principles to architectural work which distinguishes modern work from that of past times. "Mechanical principles enter into the design of our construction at every step, which our forefathers knew nothing about. Formulæ and rules are applied to such matters as arches, vaults, roofs, girders, and columns. Certain canons of proportion, geometrical and numerical, probably taught the mediæval architect how to proportion his pillars, arches, and other masses of masonry. They were results derived from experience. Now the same things are regulated by graphic statics or mathematical analysis. If we want to construct an arch of masonry that shall be in equilibrium, we proceed, according to rule, to find the load which it has to bear, and to equate the moment of thrust with that of abutment, or graphically by means of a force polygon, by which we can determine the thrust of every arch stone, or the line of resistance within the thickness of the arch. So, too, we have mechanical means of finding out what depth and size beams of iron must be in order to carry certain weights. If we discard these rules, we do so at the risk of failure. The public expects the architect to understand them,—to know what is necessary to insure stability. In such matters as hydraulic apparatus, lifts, hot- and cold-water supply, laboratory and workshop fitting up, bath and laundry arrangements, etc., mechanical considerations and contrivances enter largely into the design of the architect. They require him to study departments of science which lie outside his particular art. They often interfere with his taste, and rob him of that serenity of thought so necessary to artistic conception. At every turn engineering forces itself upon his attention; he cannot ignore it."

While there is much that is true in these remarks, it seems hardly a problem of modern work and art; the finest works of

ancient and mediæval times were executed by men who were at the same time artists and engineers, and who found that the two arts and sciences were rather mutual aids and helps than distraction. The calm study of an engineering problem often contributes as much to serenity of mind as does the contemplation of a beautiful design, and the fact that an architect has worked out the stresses and lines of resistance in an arch is more than likely to result in a graceful and artistically-proportioned piece of work.

The painter or sculptor studies anatomy, perspective, proportion, and all the scientific details of his art, and finds them aids rather than distractions. The musician does not find a knowledge of the mechanical rules of counterpoint and harmony, and of the laws of sound, a hindrance to the true mastery of the artistic side of his profession. The same should be true of the architect, and, casting aside limited and narrow ideas, he too should welcome the aid and coöperation of the engineer and his science, feeling sure that art can never suffer by close alliance with truth.

The Utilisation of Wave Power.

THE many attempts which have been made to harness the power exerted by the endless beating of the waves have been crowned with success only in a few limited instances. The reasons for this are readily found, and reside largely in the erratic nature of the motion, and in the mechanical difficulties which oppose the connection of the source of power with the shore.

One of the most successful applications of wave power, although in a most limited way, is the well-known "whistling buoy," which abstracts enough mechanical energy from the motion of the waves to keep the sound of its alarm whistle in continual action without other assistance.

The success of the whistling buoy has doubtless been the suggestion of Mr. Morley Fletcher's "Wave Power Electric Buoy," which is the latest attempt to utilise the power of the waves; and from an account in *Industries and Iron* we gather the following general description.

The principal feature of Mr. Fletcher's device is the fact that all the apparatus is contained within the buoy itself, thus getting rid, at one stroke, of the great difficulty in previous wave motors—*i.e.*, the connection with the shore.

In the interior of a floating buoy is a pump, which, by connection with the comparatively stationary anchorage, makes a stroke every time the buoy rises and falls. This pumping action, in connection with suitable air-chambers, maintains a body of water under pressure which, acting upon a hydraulic motor, keeps a dynamo in motion, and generates a current. The electric current thus generated may be used to feed a lamp upon the buoy, or, as suggested by Mr. Fletcher, may be used to charge the accumulator of an electric launch.

The details are matters which may be varied to suit the conditions of each case. The principal features to be noted here are the self-contained nature of the apparatus, and the scope afforded for the utilisation of wave power by the introduction of the idea of isolation.

It is easy to see that this idea may be extended to the motion of a vessel at sea, and that the rise and fall of the hull upon the waves—a motion which derives its origin entirely from outside sources—may be used in connection with proper storage devices to provide for much of the work now performed at the expense of much combustion of fuel.

The Stability of Channels.

ONE of the greatest difficulties encountered in connection with harbor improvement works lies in the tendency of channels formed in sandy estuaries to shift their positions, especially if there is no large river discharging through the estuary in which the channel is situated.

This question was the subject of a paper by Mr. P. M. Crosthwaite, read before the Institution of Civil Engineers at a recent meeting, and some of the points brought out are of interest.

The only action which can be relied upon when there is no river current is the scour obtained from tidal waters; in some

instances attempts have been made to assist the maintenance of a dredged channel by means of training works.

Experience has taught, however, that training works constitute a hazardous experiment, and may lead to disastrous results. While they doubtless fix the direction of the channel, the quantity of water admitted and emitted at each tide is diminished, reducing the velocity and diminishing the scouring capacity. An increase in silting necessarily follows, while those parts of the estuary behind the training work are raised and the tidal capacity of the channel diminished.

Mr. Crosthwaite contended that by the use of dredging alone these injurious results do not follow, the reduced friction causing increased velocity and scour, while the quantity of water passing up and down the channel, being greater than when training walls are used, prevents the filling up of the estuary.

As an illustration of the action of training walls, the works of Dundalk Harbour were cited. Here a small river is trained through an estuary encumbered by vast sand-banks, the walls being raised to half tide-level. As a result, the general level of the sandbanks has been raised, and in some places as much as six feet of sand have accumulated, the training wall in one place being completely buried. Large accumulations of sand have been formed in the channel, and the bar has moved about one-fourth of a mile seawards.

The navigable channel is now constricted to a narrow deep cut close to the west training wall, which it threatens to undermine; if this wall should be undermined, the river will probably form a new course for itself through the western sand banks. The actions are just what the theory of Mr. Crosthwaite indicates, and, as all these changes have occurred within the short period of fifteen years, the rapidity of the accumulation will be evident.

These works were planned nearly forty years ago, when training walls were considered the only method of dealing with such channels; but, in the light of such experience, opinions must be revised.

THE CONTINENTAL PRESS

The Prizes of the French Academy.

AMONG the important functions of the *Académie des Sciences* is that of custodian of various funds from which prizes are awarded, as well as the difficult task of deciding to whom, in the various departments of pure and applied science, these prizes are to be given. These prizes are awarded early every year, and from the account in the *Comptes Rendus* some points of interest concerning the subjects relating more nearly to engineering work may be found.

The most important award in the department of mechanics for 1897 was that of the extraordinary prize of 6,000 francs from the funds of the department of marine, which on this occasion was gained by MM. Gossot and Liouville for their investigations of the subject of resistance of simple and reinforced tubes to internal pressure, with especial reference to the stresses in the metal of hooped guns under the action of military explosives.

In the usual method of computing these stresses the question is considered as one of statical equilibrium, and a definite and uniform pressure is supposed to be exerted upon the interior of the barrel. MM. Gossot and Liouville have assumed no such simple state of affairs, but in their memoir have taken into account the fact that the sudden pressure of the explosion is a maximum at the breech, and is transmitted thence to the muzzle at a rate depending upon the rapidity of the explosion, and that it is necessary to take into account the time element, if a correct understanding of the real conditions is to be obtained.

After a number of careful experiments, a simple mathematical expression was found for the pressure at any point of the interior of a gun in terms of the time and the maximum pressure at the instant of explosion, certain constants depending upon the character of the explosive introduced. From this expression a mathe-

matical treatment based upon the elastic theory of the strength of materials was made, which enables the stresses to be computed far more intelligently than heretofore.

The Montyon prize was awarded to the engineers of the Aisne and Marne canal, MM. Bourguin, Pavie, and Pigache, for their successful application of cable traction to canal haulage. The installation for which this award was made is in the canal tunnel of Mont de Billy, this section of the canal having been for some time badly congested with traffic. The tunnel permits the passage of only a single boat, and, in spite of the use of expensive relays of horses, it has not been possible heretofore to make the passage in less than six hours; four passages, two in each direction, being made each twenty-four hours. As this canal is the principal connection between the two systems of the north and the east, and the yearly traffic has reached 1,400,000 tons, some means of relief became imperative.

The new system involves the use of an overhead cable, making haulage possible in either direction, according to the part of the cable gripped by the boat; and, apart from the economy in operating expense, the speed of traction has been increased one-third, and the loads also augmented, so that the actual capacity of the tunnel for traffic has been doubled, and the congestion in great measure relieved.

The subject announced for the Fourneyron prize was as follows:

"Give the theory of the motions, and a special discussion of the conditions of stability of apparatus of the velocipede class, bicycles, etc., both for rectilinear and curvilinear paths, either on a horizontal or inclined plane."

Ten memoirs were received in response to this announcement, only one being of a theoretical nature, the others being based upon practice; and, although several of the papers appeared worthy of seri-

ous examination, the committee deemed it advisable to prolong this competition for another year, and admit additional competitors.

Among the other awards, the following, though not directly within the domain of engineering, are of interest: the Cuvier prize of 1,500 francs to Professor Marsh, for his work in palæontology; the Lalande prize of 540 francs to Professor Perrine, for his discoveries of comets; and the LaCaze prizes to Professor Lenard for his investigations of the cathode rays, to Professor Röntgen for his applications of the X rays to therapeutics, and to Professor Sabatier for his researches in mineral chemistry.

Embankment Construction in Sliding Earth.

ONE of the most difficult problems with which the civil engineer has to contend is that of construction in those geological formations which are apt to shift and slide beneath his work, and which, even when most carefully considered, often contain such elements of uncertainty as to cause much anxiety.

A series of important papers upon this subject have appeared in the *Zeitschrift des Oesterr. Ingenieur und Arch. Vereines*, prepared by engineers Ottokar Soulavý and Carl Schmidt, with examples of various cases which have occurred in practice. The discussion of the whole subject is made from the standpoint of the railway engineer, especially with regard to reconstruction work upon locations where landslides have taken place, and hence is eminently practical in its nature.

Landslides occur because of the destruction of the equilibrium between the various masses of earth concerned, usually by reason of changes in the cohesion and frictional resistance originally existing. Since both the friction and the cohesion may be considered as passive forces, acting by resistance, the modification must come from some outside source. If, for example, we have a mass of earth more or less permeable by water, and resting upon an inclined stratum of non-permeable material, such as clay, we have all the ele-

ments for a landslide. From the action of moderate rains the upper stratum becomes soaked, the water which cannot pass through the clay forming a lubricating sheet between the two formations, and, as soon as a heavy rain comes, the whole upper mass slides, until a new position of equilibrium is attained. When the angle of the lower stratum is not greater than even the reduced angle of repose, the deformation occurs when the cohesion of the entire mass becomes unequal to sustaining the load upon it; hence we have two classes of disasters,—landslides proper, and failures from lack of cohesion. The principal cause of both kinds of failure is the presence of accumulated water, either in the form of ground water, rain, melting snow, or flood, and it is in connection with such conditions that the maxim of Sarilly applies: "The fear of clay and water is the beginning of wisdom."

In providing proper drainage to carry away the water which would otherwise accumulate at the dividing plane between the strata, numerous precautions are necessary, in order to insure prevention of sliding, and in the examples given both successful and unsuccessful constructions are shown. In one instance the construction of a cemented dam parallel with the railway on its upper side, with a longitudinal drain at its base, did not prove sufficient, although the dam was carried down below the level of the clay stratum; but the cutting of deep trenches at right angles to the roadway and about one hundred feet apart, forming cross drains filled with broken stone, relieved the accumulated water from surface drainage and from ground water sources, and provided effectually against further trouble.

In another case provision for under-drainage was made by the use of cast-iron-pipe drains, aided by auxiliary stone channels, a retaining wall being also provided at the base of the original slope. Although this answered for several years, a gradual sliding took place, which disturbed the continuity of the drains, and a rapid thaw, after a heavy winter, caused a serious landslide, which completely overwhelmed the retaining wall, and involved

the reconstruction of the work on a much more extensive scale. An entire regrading of the slope was made, and a new double retaining wall built, while several large masonry drains replaced the iron pipes giving full relief to the water and preventing the possibility of further accumulation.

It is impracticable, in the limited space here available, to give the details of these and other interesting examples contained in the paper, and for fully-illustrated accounts reference must be had to the original publication, which is worthy of the examination of the engineer who has to contend with similar problems. When the cost of proper protection against landslides is fully considered, however, Herr Soulavay maintains that it is cheaper and safer to build open viaducts in nearly all cases than to construct embankments and provide the necessary drainage tunnels and retaining walls.

A Swiss Compound Locomotive.

MORE than ten years ago the three-cylinder compound locomotives designed by Mr. Webb and built at Crewe for the London & Northwestern Railway were the subject of much interested discussion, and now we have a compound engine for use on the Simplon-Jura road in Switzerland, which, while similar in general appearance, is really just the reverse in arrangement and operation.

The Webb locomotive is made with two outside-connected high-pressure cylinders and one inside low-pressure cylinder, the outside connections being made to the rear axle and the inside cylinder connecting only to the forward cranked axle. There are no parallel rods, the relative positions of the pistons being controlled only by the steam distribution.

The new Swiss engine, as illustrated in the *Schweizerische Bauzeitung*, has one high-pressure cylinder inside, of 20.4 inches diameter, and two outside-connected low-pressure cylinders 21.25 inches bore, the three driving-axles being also connected by parallel rods, to which there is no objection in the mountain service for which the engine is intended, where a

maximum speed of not more than 45 miles per hour is demanded. All three cylinders are provided with the Walschaert valve gear, so generally used in Switzerland and Belgium, and the boiler is intended to carry 200 pounds' pressure, an unusually large grate surface being provided in order to insure ample steaming capacity on the heavy grades.

By providing connections to enable the outside cylinders to be operated with high-pressure steam the engine is at once converted into a full-power simple locomotive, and in this manner ample starting power is obtained. When very heavy inclines occur, high-pressure steam can be used in all three cylinders, while for ordinary service an economical compounding is obtained by running the outside cylinders low-pressure with the steam from the single inside cylinder.

The total weight of the engine is 55 tons (metric), of which 44.5 tons rests on the six driving-wheels, and the success of the first of the design has been such that twenty-five engines of identical construction are now being built for use on the Bale-Delle section of the Simplon-Jura Railway.

An Important Power Plant.

THE company originally formed to exploit the distribution of compressed air in Paris has turned its attention largely to the generation and distribution of electricity, and has recently erected and equipped a large and important electric power plant on the Quai de Jemappes in Paris, of which a full account is given in *Le Génie Civil*.

Until recently the Paris company has been operating with a number of substations with transformers and accumulators, fed from two principal generating stations which furnished the high tension current. The expense for attendance which the maintenance of numerous sub stations involved has led to a rearrangement of the distribution system, and the result has been the construction of the fine new central power and electrical station to which reference has been made.

The site, close to the canal Saint-Martin, is rectangular, and covers an area of

nearly 60,000 square feet. This location is admirably adapted for the delivery of fuel,—which, when the station is running full, will amount to 140 tons per day,—and also provides an ample supply of water for condensing purposes.

The structure consists of a main central building containing the boilers, engines, and generators, with pavilions at each end for the auxiliary electrical apparatus and for the administrative offices.

The main building is arranged to contain the engines and generators in the lower portion, this part of the structure being of masonry, and carrying the boiler rooms, of iron and steel, above it.

The power house thus forms a rectangular hollow square, while in the central space, leaving sufficient room for light and air all around it, is an interior building containing the coal elevator, ash discharge, water connections and purifiers, and much of the auxiliary apparatus.

The power room proper is one of the largest yet in operation, containing twenty-three direct-connected engines and generators, each of 1,200 h. p., thus giving a total of 27,600 h. p., while in the room above are the boilers, arranged in groups of four for each engine. The engines are of the vertical compound Corliss type, with jet condensers, the cylinder ratio being 1:2.84, for a boiler pressure of about 110 pounds. The boilers are of the Belleville water-tube type with automatic feed and attached super-heaters, each group of four boilers having its own sheet-iron chimney, $6\frac{1}{4}$ feet in diameter and 65 feet high. Upon test, the steam consumption per i. h. p. was found to be 14.6 pounds per hour, including jacket supply and all other auxiliaries, this value being measured by the total steam delivered by the boilers.

The direct-connected dynamos are arranged normally to furnish each a current of 1,500 amperes at 500 volts tension, or 750,000 watts, although, if required, a tension of 600 volts can be supplied.

The electrical details of the plant are notable only because of the magnitude of the installation, but there are many details of the building and its contents which

are of interest to the engineer. The constructive details are well shown by numerous sections and plans, while photographs of the work in course of construction show clearly the manner of building. The conditions of stability were especially well studied, and the distribution of the loads and the method of their support are discussed at length, so that the description of this work is available for use in connection with similar structures elsewhere.

The architectural portion of the work was in the hands of M. Friese, by whom all the structural computations were made, while the machinery was furnished by the Société Alsacienne de Constructions Mécaniques, the details, wiring, and general arrangements being made under direction of the engineers of the compressed air company. The entire work is important, both because of its magnitude and for the judgment and skill displayed in its design and execution.

The Magnetic Properties of Tempered Steel.

It is not often that a scientific paper written by a woman is accepted for publication by the French Academy, but the recent memoir upon the magnetic properties of tempered steel, by Madame Sklodowska-Curie, which has been thus honored, is a thoroughly scientific investigation, and, in addition to the place in the *Comptes Rendus*, a more extended and original account of her work in this field is given in the *Bulletin de la Société d'Encouragement*.

The experiments were made upon selected bars of steel of various chemical composition from numerous sources, the specimens having been selected by Professor Le Chatelier, who also made a chemical analysis of each bar.

Each bar was magnetized to saturation, and determinations made of the coercitive field and the intensity of the remanent magnetism at the middle point. After having determined the properties of the various specimens, the following interesting and apparently original investigation was made. The bar of steel was placed in a porcelain tube heated by means of a

spiral of platinum wire traversed by an electric current. A double effect is thus produced; the current magnetizes the steel, and the heat raises its temperature. The magnetic condition can be continually investigated by a magnetic needle, and, when the temperature becomes sufficiently high, the bar is no longer magnetic. Now, Madame Sklodowska-Curie announces that the temperature at which the magnetic effect disappears is also the temperature which must be exceeded before the bar can be tempered. It thus follows that the steel can be tempered only after the magnetic transformation has taken place, when little or no magnetism exists in it.

Many of the details of the investigation are at present only of laboratory interest, but among the results of immediate practical value are those relating to the best percentage of carbon, and also those relating to the influence of other elements upon the suitability of the steel for permanent magnets.

So far as carbon is concerned, steels containing from 1.1 to 1.2 per cent. of carbon appeared to give the best results, while the presence of molybdenum or tungsten increased the coercitive effect, the highest effect being produced by 3.5 to 4 per cent. of molybdenum.

Investigations were also made upon the effect of repeated shocks, this being found to be less as the coercitive field is greater. The paper is a material addition to our knowledge of the conditions under which the best permanent magnetic effects can be produced, and, so far as such magnets are likely to be used in practical work, is of more than passing importance.

The New Collecting Sewer at Vienna.

A VERY important piece of municipal work at present under construction is the new collecting sewer on the right bank of the Danube canal, in Vienna, and a visit of inspection recently made by the Austrian Society of Engineers resulted in an interesting account of the works, published in the *Zeitschrift des Oesterr. Ing. und Arch. Vereines*.

The purpose of this sewer is to divert from the canal all offensive sewage and drainage,

and to provide for the entire discharge of all the existing sewers of the city on the right bank, delivering the sewage into the Danube below the city. The large area thus drained includes many former streams which have been arched over in the built-up portion of the city. It would be impracticable to provide a collector of sufficient capacity to receive all the storm water in time of sudden and heavy rainfall, but this problem has been met by providing suitable overflow connections to the canal, which, coming into service only when the sewage is greatly diluted with rain-water, do not cause any perceptible nuisance.

The large size of the sewer, and the fact that its line lay directly through an important part of Vienna, introduced some difficult constructive problems, especially in connection with the underpinning of foundations of handsome and important buildings, the trench in some instances extending from curb to curb with a depth of 30 to 40 feet.

The soft nature of the soil in the open part of the excavation—soil which is practically the alluvium of the Danube—made it very necessary that the sides of the excavation should be most thoroughly braced, and the photographs of the work in progress show how great care was taken in this respect. In view of the character of the ground, pains were taken to insure a sufficient foundation for the masonry, piling being used where necessary, and the weight of the masonry being distributed by inverted arches upon concrete bedding.

The arch of the main subway is 24 feet span and 12 feet rise, with a channel 15 feet wide and 3 feet deep along the bottom, much as in the great Paris sewers, this leaving a footway along each side, by which the passage can ordinarily be traversed, while providing a large area above in times of emergency. Where the sewer is divided into two branches, as is the case just above the overflow at the Sofien bridge, the size is reduced in one case to 14 feet span by 10 feet rise, and in the other to 10 feet span by 7½ feet rise; in the latter case a portion of the work was

done by tunnelling, instead of opening a trench for the entire length. An interesting feature in connection with a portion of the tunnel work was the fact that the massive foundations of the old walls of Vienna lay in the path of the tunnel, and offered no small obstruction to the work.

An interesting feature in connection with the work is the extensive use of electric power for the removal of infiltrating water. Electric motors operating centrifugal pumps furnished a very satisfactory combination, the current being taken from the mains of the local electrical company, although in some cases portable steam engines and pumps were also used. The great convenience which the portable character of the electric motor and pump combination affords renders it especially adapted for contractor's service in work of this nature, there being eight electric motors used for this purpose and only two steam pumps.

The work upon the sewer was commenced only in September, 1897, and already more than one-third is completed, so that by the close of the present year this extensive municipal improvement will doubtless be an accomplished fact.

The Electrical Ignition of Fire-Damp.

A SERIES of very important investigations has recently been made in Germany by Messrs. Heise and Theim, and published in the *Elektrotechnische Zeitschrift*, upon the conditions under which fire-damp and coal dust in mines are ignited by the action of electrical apparatus. This is a matter of increasing importance, in view of the extending use of electrical machinery in mining work, not only for lighting purposes, but also for operating numerous forms of machinery. Generators, motors, drills, pumps, and similar electrical appliances are coming into general use, and the dangers from sparking, or from the possible production of high temperatures, such as overheated wires, short circuits, and the like, as well as the influence of exposed arcs or broken incandescent lamps, must all be taken into account in connection with the presence of explosive mixtures of gas and air.

A portion of the tests were made in a sort of wooden tunnel of elliptical section about 4 feet by 6 feet by 100 feet, while for some of the experiments a smaller chamber, with a capacity of about 350 cubic feet, was used. These chambers were made of wooden staves, hooped with T-iron bands; and safety windows covered with paper were provided, as well as heavy glass windows, for observation. The long chamber was partly buried in the earth, and by use of steam piping the temperature could be controlled in all weather. The gas tested was drawn from behind a bulkhead separating a gaseous working of the *Consolidation Brabauerschaft*, and a mechanical mixing apparatus insured a thorough mingling of the air and gas before testing. Fire-damp is explosive only when mixed with air in proportions between 5 1-2 and 14 1-2 per cent., the most violent explosions occurring when from 9 to 10 per cent. of methane is present; and, in order to make the tests cover the point of greatest risk, a mixture of 9 per cent. was employed. During prolonged tests samples of gas were drawn off from time to time and tested, thus avoiding the possibility of uncertainty on this point.

The first tests were made with exposed loops prepared by removing the bulbs from a number of incandescent lamps, the current being passed through until the loops became white-hot and finally burned off. Under these conditions the gas was ignited, but usually the explosion was deferred until the moment of breaking of the filament. Perfect lamps were then placed in the explosive mixture, and the bulbs broken, thus reproducing conditions which are apt to occur in practice.

The results of these experiments were somewhat varied, certain lamps failing every time to ignite the gases, while others as regularly proved dangerous. There seemed to be no difference in the action of continuous and alternating currents, and the different action of lamps made for use with various voltages seemed to indicate that it was the variation of current strength which caused the results observed. No explosions were caused by the breaking off of the nipple of the bulb, as

the gas entered slowly, and the filament burned out quietly.

Tests which were made with arc lamps showed that the arc was a very effective igniter of explosive gas mixture, but that it declined to explode either air charged with coal dust or a mixture of coal dust and air containing a small proportion of methane.

Very full experiments were made on all kinds of sparking connections, such as switches and dynamo and motor brushes, as well as fuses, with the result that all sparks were found to be an element of danger, although in some instances they failed to cause explosion.

In general, the experiments led to the following conclusions. Arc lamps should not be permitted in gaseous mains, nor should incandescent lamps be used with current above 0.6 ampere or voltage above 150 volts. Continuous current motors are apt to produce sparking, but three-phase motors with two brushes are safe. Switches should be enclosed, as should fuses also. Especial care should be given to all connections, and the greatest dangers appear to be due to the parting of connections for any reason, and the consequent production of arcs or sparking.

These investigations are really only preliminary, and should be considered as a foundation upon which to base other experiments; so considered, the work appears to have been well done, and the methods for future procedure appear to have been well marked out.

Electric Mountain Roads.

THE especial adaptation of electric power for the operation of mountain railways has gradually become recognized, and it is not at all unlikely that before long the trolley system will be the only one in use for these mountain-climbing roads. It is the overhead trolley which has been adopted for the road to the summit of the Jungfrau, now under construction, and a similar system is intended for the rack railway projected between Chamounix and Montenvert. Quite in advance of these, however, is the electric rack railway from Zermatt to the Gorner-

grat, so well known to tourists for the magnificent panorama of the Southern Alps from Monte Rosa to the Matterhorn.

An excellent illustrated account of the construction of this new road, a portion of which has recently been completed, is given in *Le Génie Civil*, and both the electrical and the engineering features are worthy of attention.

Since 1891 a combined adhesion and rack railway has enabled the valley of Zermatt to be readily reached by travellers, but the ascent to the Gornergrat, over 10,000 feet above the sea-level, and more than 5,000 feet above Zermatt, has until now been reached only by climb afoot or on horseback.

As in the case of the Jungfrau road, the motive power is obtained from a mountain stream conveniently available, a head of over 300 feet being attained with an ample supply of water for the work to be performed during the few months which constitute the travelling season. The only points of novelty about the power plant are the ingenious devices to protect the machinery from injury by the possible sudden changes of load. Since it is quite possible that three fully-loaded trains may be thrown off at the same time, it is possible for the load upon the turbines to be varied from 0 to 500 h. p. within a few minutes. This is especially difficult to manage when the full load is thrown off, because the governor must check the water immediately to prevent the machinery from "running away," while the sudden check is likely also to produce violent water-hammer in the supply pipe. These requirements are met by a sensitive governor operating in connection with an air-compressor and reservoir of compressed air, which latter serves as a source of power for the prompt operation of the turbine gates, while the water-hammer is prevented by a relief valve, which is automatically opened whenever the turbine gates are suddenly closed, thus affording relief to the suddenly-checked water column. A sort of dash-pot connection permits this relief valve to close gradually soon after it has been opened, thus preventing any continuous

waste of water. Care is also taken to strain the water in order to insure the absence of *débris* which might find its way into the turbines and disable them.

A three-phase electric system is used with a frequency of 40 periods per second, the generators being of the well-known construction of Messrs. Brown, Boveri & Co. Like most mountain roads, the route of the railway line zigzags up the mountain side in a manner controlled by the grade and topography, but the feeders are much shorter than the railway, being carried directly across the loops in the route, and enabling three transforming stations to be fed with only about half as much length of conductor as would otherwise have been necessary.

The total length of the road is 5.7 miles, and the difference in altitude of the two stations 5,230 feet, or very nearly one mile; hence the average grade is 17.5 per cent. The steepest grade attained on the road is 20 per cent., near the summit.

The work includes four tunnels, of which the longest is 650 feet, several bridges, of which the most important is one at Visp about 90 feet long, and a viaduct over the Findelenbach, near the power house, consisting of three steel arches of 130 feet span each. The road is constructed on the Abt system, so generally used in Switzerland, and the work, as far as constructed, is of the most substantial character.

In the construction of the electric locomotive every care has been taken to secure ample power both for propelling and braking, two motors of 90 h. p. each being provided, each geared to a separate axle. The locomotive itself weighs 10.5 tons, and draws two cars, one open and the other closed, with a total capacity for 110 passengers, the entire estimated load being about 28 tons.

A portion of the road was completed before the approach of winter interrupted the work, and since November this has been under trial with satisfactory results. It is expected that the work will be completed in time for use by July of this year, thus making this the first mountain electric road on the triphase system.

Silico-Portland Cement.

THE questions of the importance of thorough admixture of the constituents of a cement mortar, and of the influence which the fineness of the sand has upon the resistance of the hardened material, have been discussed by several engineers, and investigated in the testing laboratories of Paris and Berlin.

A practical application of the knowledge thus acquired is seen in the works of the *Société des Ciments Français*, in the manufacture of what is termed Silico-Portland cement, a general account of which we take from *La Revue Technique*.

It has been found by experience that the diminution in strength shown by adding sand to neat cement is due both to the reduction in the proportion of cement in the mixture, and to the presence of voids between the particles, caused in part by the coarseness of the sand and in part by the fact that the sand and cement cannot be perfectly mixed in the preparation of the mortar, a sort of segregation taking place which results in weak spots and defective hardening.

The method of preparation consists in mixing one or two parts of sand with one of cement, and grinding the mixture to the degree of fineness usually given to the neat cement. The additional proportion of sand is then added, bringing the total to six parts of sand to one of cement, the difference being in the fact that a portion of the sand is so finely ground and so thoroughly mixed that it practically forms a portion of the cement and assists especially in filling the voids which otherwise would exist in the set and hardened mixture.

Tests which have been made with this simple modification of ordinary cement mortar show a large increase in strength and reliability, or—what is the same thing—a possibility of effecting a marked economy in cement for the same strength. A mortar consisting of silico-cement and sand corresponding to a proportion of 1 part of cement to 11 parts of sand gave under test a higher resistance than did a mixture of 1 part of cement to 3 parts of sand made in the ordinary manner.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine, printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of \$1.25. In ordering, care should be taken to give the number of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for \$2, forty for \$5, and one hundred for \$12.

This Coupon will be received by us in payment for any 15 cent article catalogued in "The Engineering Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents; thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.

The Engineering Magazine, New York:

Please send Article No. _____ to the following address: _____

Facsimile Not Good

With a supply of these coupons on hand, no letter writing is required. Simply fill in the number and your address. A stamped envelope does the rest.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

- | | |
|--|---|
| American Architect. <i>w.</i> Boston, Mass. | Bulletin de la Société d'Encouragement. <i>m.</i> Paris. |
| American Electrician. <i>m.</i> New York. | Bulletin of Dept. of Labor. <i>b-m.</i> Washington, D. C. |
| Am. Engineer and Railroad Journal. <i>m.</i> New York. | Bulletin of the Univ. of Wisconsin, Madison, Wis. |
| American Gas Light Journal. <i>w.</i> New York. | California Architect. <i>m.</i> San Francisco, Cal. |
| American Geologist. <i>m.</i> Minneapolis, Minn. | Canadian Architect. <i>m.</i> Toronto, Ont. |
| American Journal of Science. <i>m.</i> New Haven, Conn. | Canadian Electrical News. <i>m.</i> Toronto, Ont. |
| American Journal of Sociology. <i>b-m.</i> Chicago, Ill. | Canadian Engineer. <i>m.</i> Montreal, P. Q. |
| American Machinist. <i>w.</i> New York. | Canadian Mining Review. <i>m.</i> Ottawa, Ont. |
| Am. Manufacturer and Iron World. <i>w.</i> Pittsburg, Pa. | Century Magazine. <i>m.</i> New York. |
| American Shipbuilder. <i>w.</i> New York. | Chautauquan. <i>m.</i> Meadville, Pa. |
| Am. Soc. of Irrigation Engineers. <i>qr.</i> Denver, Col. | Chem. Met. Soc. of S. Africa. <i>m.</i> Johannesburg, S. A. R. |
| Annals of Am. Acad. of Pol. and Soc. Sci. <i>b-m.</i> Phila., Pa. | Colliery Guardian. <i>w.</i> London. |
| Annales des Ponts et Chaussées. <i>m.</i> Paris. | Compressed Air. <i>m.</i> New York. |
| Architect. <i>w.</i> London. | Comptes Rendus de l'Acad. des Sciences. <i>w.</i> Paris. |
| Architectural Record. <i>q.</i> New York. | Consular Reports. <i>m.</i> Washington, D. C. |
| Architectural Review. <i>s-q.</i> Boston, Mass. | Contemporary Review. <i>m.</i> London. |
| Architecture and Building. <i>w.</i> New York. | Deutsche Bauzeitung. <i>b-w.</i> Berlin. |
| Architektonische Rundschau. <i>m.</i> Stuttgart. | Dingler's Polytechnisches Journal. <i>w.</i> Stuttgart. |
| Atlantic Monthly. <i>m.</i> New York. | Domestic Engineering. <i>m.</i> Chicago, Ill. |
| Australian Mining Standard. <i>w.</i> Sydney. | Eclairage Electrique. <i>w.</i> Paris. |
| Automotor and Horseless Vehicle Journal. <i>m.</i> London | Electrical Engineer. <i>w.</i> London. |
| Bankers' Magazine. <i>m.</i> New York. | Electrical Engineer. <i>w.</i> New York |
| Bankers' Magazine. <i>m.</i> London. | Electrical Engineering. <i>m.</i> Chicago, Ill. |
| Bankers' Magazine of Australia. <i>m.</i> Melbourne. | Electrical Review. <i>w.</i> London. |
| Berg- und Hüttenmännische Zeitung. <i>w.</i> Berlin. | Electrical Review. <i>w.</i> New York. |
| Board of Trade Journal. <i>m.</i> London. | Electrical World. <i>w.</i> New York. |
| Boston Journal of Commerce. <i>w.</i> Boston, Mass. | Electrician. <i>w.</i> London. |
| Bradstreet's. <i>w.</i> New York. | Electricien. <i>w.</i> Paris. |
| Brick Builder. <i>m.</i> Boston, Mass. | Electricity. <i>w.</i> London. |
| British Architect. <i>w.</i> London. | Electricity. <i>w.</i> New York. |
| Builder. <i>w.</i> London. | Elektrochemische Rundschau. <i>b-m.</i> Frankfurt. |
| Bulletin Am. Iron and Steel Asso. <i>w.</i> Phila., Pa. | Elektrochemische Zeitschrift. <i>m.</i> Berlin. |
| | Elektrotechnisches Echo. <i>w.</i> Magdeburg. |
| | Elektrotechniker. <i>b-m.</i> Vienna. |

- Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Engineer. *w.* London.
 Engineer. *s-m.* New York.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, Tenn.
 Engineering and Mining Journal. *w.* New York
 Engineering Magazine. *m.* New York & London
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
 Fire and Water. *w.* New York.
 Forester. *m.* Washington, D. C.
 Foundry. *m.* Detroit, Mich.
 Gas Engineers' Mag. *m.* Birmingham, England.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Gunton's Magazine. *m.* New York.
 Harper's Weekly. *w.* New York.
 Heating and Ventilation. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago, Ill.
 Iron Age. *w.* New York.
 Iron and Coal Trades' Review. *w.* London.
 Iron & Steel Trades' Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco, Cal.
 Journal Franklin Institute. *m.* Phila., Pa.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *q.* New London, Conn.
 Journal Political Economy. *q.* Chicago, Ill.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kan.
 Locomotive. *m.* Hartford, Conn.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore, Md.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Master Steam Fitter. *m.* Chicago, Ill.
 Mechanical World. *w.* London
 McClure's Magazine. *m.* New York.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, Pa.
 Mining and Sci. Press. *w.* San Francisco, Cal.
 Mining Industry and Review. *w.* Denver, Col.
 Mining Journal. *w.* London.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Monatsschrift des Württ. Vereines für Baukunde.
 10 parts yearly. Stuttgart.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, Ind.
 National Builder. *m.* Chicago, Ill.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Physical Review. *b-m.* New York.
 Plumber and Decorator. *m.* London
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineer's Club. *q.* Phila., Pa.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago, Ill.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago, Ill.
 Railway & Engineering Review. *w.* Chicago, Ill.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revue de Mécanique. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Sanitarian. *m.* Brooklyn, N. Y.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerisches Bauzeitung. *w.* Zurich.
 Science. *w.* Lancaster, Pa.
 Scientific American. *w.* New York
 Scientific Am. Supplement. *w.* New York
 Scientific Machinist. *s-m.* Cleveland, Ohio.
 Scribner's Magazine. *m.* New York
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, N. Y.
 Southern Architect. *m.* Atlanta, Ga.
 Stahl und Eisen. *s-m.* Dusseldorf.
 State's Duty. *m.* St. Louis, Mo.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, N. J.
 Stone. *m.* Chicago, Ill.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston, Mass.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. Civil Engineers. *m.* New York
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago, Ill.
 Western Railway Club. Pro. Chicago, Ill.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, Conn.
 Zeitschrift für Lokomotivführer. *m.* Hannover.
 Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Architectural Creation.

The Creation and Production of Architecture. George Aitchison. Presidential address delivered to students at the Royal Inst. of British Architects. Remarks on the causes of the great architectural epochs of Europe, the necessary requirements to produce fine architecture, and the aim of true architects. 2000 w. Brit Arch—Jan. 28, 1898. No. 18282 A.

Astoria Hotel.

The New Astoria Hotel. Illustrated description of this fine hotel in New York city. 4 plates. 2000 w. Arch & Build—Feb. 5, 1898. No. 18225.

Beams.

See Civil Engineering, Miscellany.

Bracing.

Bracing in High Buildings. A. W. Barnes. Submitted to the International Convention of Building Commissioners and Inspectors, at Detroit. A discussion of the subject, and urging more uniformity in practice. 1600 w. Arch & Build—Feb. 12, 1898. No. 18345.

Cities.

Building Reform in Cities. (Stadtbau Reform.) Dr. Schmidkunz. A general discussion of the defective plans of most European cities with suggestions for improvements as to lighting, communication, and beauty. 5000 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1898. No. 18562 D.

Composition.

Architectural Composition. F. T. Baggalley. Extract from paper read before the British Architectural Assn. Considers a few prominent points in the art of architectural composition. 3500 w. Brit Arch—Jan. 21, 1898. No. 18120 A.

Corrosion.

See Civil Engineering, Miscellany.

Court Buildings.

The New Court Buildings in Munich. (Das Neue Justizgebäude in München.) General description, with plans, sections and photographs of this fine new government building. Three articles, three plates. 3500 w. Schweizerische Bauzeitung—Jan. 22, 29, Feb. 5, 1898. No. 18556 G.

Decoration.

The Evolution of Decorative Motives. A. D. F. Hamlin. Part first deals with the history and development of ornamental art, and the principles that control decorative composition. 3300 w. Am Arch—Jan. 29, 1898. Serial. 1st part. No. 18097.

Drawings.

The Drawings in the R. I. B. A. Students' Competitions. Ernest George. Critique on the designs and drawings submitted for the R.

I. B. A. prizes and studentships. 2500 w. Brit Arch—Jan. 28, 1898. No. 18283 A.

Dwellings.

Designs for Popular Dwellings in Vienna. (Entwürfe für Volkswohnungen in Wien.) Giving the prize designs submitted in the recent Austrian Jubilee competition, for model dwellings to advance comfort and health. Serial. 1st part. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 11, 1898. No. 18543 B.

Fireproofing.

Effective Fireproofing. Describes a fire in a building for light manufacturing purposes, which, though lasting two hours, was confined to one floor by the fireproofing. 1500 w. Eng Rec—Jan. 29, 1898. No. 18150.

Fireproof Buildings. Edward Atkinson. A warning concerning the present construction of many steel- and iron-framed buildings, with report of the destruction by fire of a so-called "fireproof" factory in Burnley, Eng. Ill. 2500 w. Am Arch—Jan. 29, 1898. No. 18098.

Fireproof Construction of Domestic Buildings. Thomas Potter. Discusses means of fire protection for buildings used wholly or mainly for habitation. Also discussion. Ill. 12500 w. Jour Soc of Arts—Jan. 28, 1898. No. 18284 A.

The Construction of Slow Burning Buildings. Francis C. Moore. Especially devoted to such details of residence construction as affect the safety from destruction by fire. Formal specifications governing the most important features are given. 3500 w. Engineering Magazine—March, 1898. No. 18594 B.

Foundations.

Shoring the Walls of an Old Building. Illustrates method of carrying walls on small cylinder piers. 2500 w. Eng Rec—Feb. 5, 1898. No. 18217.

Substructure Work in an Office Building. Illustrated description of the unusual grillage foundations of the Singer Building, New York. 900 w. Eng Rec—Feb. 26, 1898. No. 18675.

Framework.

The Computation of the Upright Members of Iron Framework. (Die Berechnung der Ständer Eisener Wandfachwerke.) L. Geusen. An elaborate mathematical paper discussing the influence of wind pressures and other sources of lateral stress, and giving many diagrams of various constructions with their analyses. Two articles. 12000 w. Zeitschr d Ver Deu Ing—Jan. 15, 22, 1898. No. 18547 G.

Monier System.

Calculations for the Monier System of Construction. (Zur Berechnung von Monier-Constructionen.) A. Ostensfeld. A mathematical treatment of the proportions of structures of the combined iron and concrete, including both beams and arches. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 14, 1898. No. 18501 B.

Park Building.

Corlears Hook Park Overlook. Illustrates

and describes a building 149 by 34 ft. for recreation and toilet purposes in a New York park. 1200 w. Eng Rec—Feb. 12, 1898. No. 18362.

Roof.

The Application of Link Connections to Roof Construction. (Der Anwendung von Gelenkträgern bei Dachkonstruktionen.) A discussion of the advantages of the link and pin connected system for roof trusses as compared with riveted construction. 1200 w. Schweizerische Bauzeitung—Feb. 5, 1898. No. 18558 B.

Steel Construction.

Two Questions in Connection with Steel Construction in Buildings. Edmund Burke. Read at the annual convention of the Ontario Assn. of Architects. The questions considered are protection from rust, and from high temperature caused by fire. Discussion. 5000 w. Can Arch—Feb., 1898. No. 18456 c.

HEATING AND VENTILATION.

Electric Heating.

A Survey of the Possibilities of Electric Heating and Cooking. W. P. Adams. Aiming to give a better understanding of the possibilities of electric heating. Part first deals with electric cooking, especially the cost. 1500 w. Elec, Lond—Jan. 28, 1898. Serial. 1st part. No. 18234 A.

Low Pressure.

Low Pressure Steam Heating Apparatus with Air Regulation. (Niederdruck Dampfheizung mit Ventil-Luft-Regulierung.) The Polle system provides an automatic method of admitting air into the radiators to reduce the temperature when it becomes too high. 1800 w. Gesundheits Ingenieur—Jan. 15, 1898. No. 18554 B.

School Ventilation.

Ventilation of a Washington, D. C., School. A description of the latest type of hot-blast heating installations. Ill. 1200 w. Eng Rec—Feb. 26, 1898. No. 18676.

Steam Injection.

Heating Water by the Direct Injection of Steam. An article in partial answer to queries received concerning the amount of coil surface, the best size of pipe, and time required to heat a given number of gallons of water through a given range of temperature. 1500 w. Locomotive—Jan., 1898. No. 18406.

Ventilation.

Study of Carbonic Oxid in Confined Air. (Recherche de l'Oxyde de Carbone dans l'Air Confiné.) Dr. Grehant. With an account of experiments upon animals showing the absorption of carbonic oxid by the blood, and also the production of carbonic oxid when air comes in contact with the metal of red hot stoves. 3000 w. Le Génie Civil—Jan. 8, 1898. No. 18506 D.

LANDSCAPE GARDENING.

School Gardens.

School Gardens. Henry Lincon Clapp. Describes the school gardens of many parts of Europe, discusses their educational value, and

suggests their general adoption in the United States. Ill. 3800 w. Ap Pop Sci M—Feb., 1898. No. 18123 D.

PLUMBING AND GASFITTING.

Hospitals.

The Plumbing, Water Supply and Drainage of Hospitals. William Paul Gerhard. Reprint from the *Albany Medical Annals*. Calls attention to the matters of greatest importance. The necessity of plenty of light, fresh air and absolute cleanliness; discussing water supply, sewerage and plumbing. 13500 w. No. 18232 D.

Plumbing Law.

Ohio Plumbing Law Held to be Unconstitutional. The opinion of Judge Kohler, of the common pleas court of Salem County, Ohio, which declares the Ohio State law to be unconstitutional. 4500 w. Dom Engng—Feb., 1898. No. 18617 c.

Sacramento.

Plumbing Ordinance in Sacramento, Cal. A copy of an ordinance that has been in force more than a year. 3500 w. San Plumb—Feb. 15, 1898. No. 18476.

MISCELLANY.

Accounts.

Accounts for Architects. Henry Calder Marshall. Read before the Society of Architects, London. Shows the advantage of keeping proper accounts, and explains a simple system suitable for the profession of an architect. 3300 w. Arch, Lond—Feb. 11, 1898. Serial. 1st part. No. 18499 A.

Architects' Mortality.

Rate of Mortality Among Architects and Building Artisans. Lessons to be learned from the Blue Book by Dr. Tatham entitled "Supplement to the Fifty-fifth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England." 2700 w. Builder—Feb. 5, 1898. No. 18391 A.

Architectural Development.

The Historical Development of Architecture. W. J. Anderson. Abstract of a course of lectures being delivered this Session before the Glasgow School of Art. Part first covers the first eight lectures. 2400 w. Jour Roy Inst of Brit Archs—Jan. 8, 1898. No. 18114 B.

Building Disaster.

The London Building Disaster. An effort to determine as nearly as possible the cause of the disaster at London, Ont., by which many lives were lost. 2700 w. Can Arch—Feb., 1898. No. 18455 c.

Competition.

The California University Competition. Editorial on this proposed international competition, giving an outline of the arrangements. 2300 w. Builder—Feb. 12, 1898. No. 18491 A.

The Phebe Hearst Architectural Competition for the University of California. Abstract of the programme with map. 3000 w. Jour Roy Inst of Brit Archs—Jan. 29, 1898. No. 18687 B.

Electrical Action.

Electricity in Modern Buildings. Considering whether there will take place any interaction between the steel framework and the electrical circuits which distribute the lighting and power currents. 1000 w. Can Elec News—Feb., 1898. No. 18363.

Fire and Water.

Fire-and-Water Resistance. Howard Constable. Extracts from a paper read before the Boston Society of Architects. On the necessity of further development in the direction of fire prevention. 2800 w. Am Arch—Feb. 19, 1898. No. 18615.

Glass.

Soluble Glass in House-Construction. C. Colné. On the properties, application and use of soluble glass, which is in favor in Europe. 2500 w. Am Arch—Feb. 12, 1898. No. 18356.

Hampton Court.

Hampton Court Palace. John Belcher. Read at meeting of the Architectural Assn., London. The building is considered from the architectural standpoint, giving history of the work from its beginnings. Discussion. 7800 w. Builder—Feb. 12, 1898. No. 18494 A.

Jews.

The Jews in Art and Architecture. Reviews the attitude of the Jews toward art in the earliest history and briefly traces the development. 1600 w. Stone—Feb., 1898. No. 18438 C.

London Fire.

The Cripplegate Fire and Its Lessons. Editorial on the reported investigations of a committee appointed to inquire into the possibilities of improvement in the burned district, in order to prevent a repetition of the catastrophe. 1800 w. Engng—Jan. 28, 1898. No. 18268 A.

Medusa.

The Medusa Myth in Greek Art. The extensive use of this emblem and the chief points of the story as illustrated in ancient art. 4500 w. Arch, Lond—Jan. 28, 1898. No. 18293 A.

Memoir.

The Late John Loughborough Pearson. An interesting sketch of the life of this noted architect and his most famous works. 3000 w. Jour Roy Inst of Brit Archs—Jan. 8, 1898. No. 18112 B.

Mosque.

The Great Mosque of the Omeiyades, Damascus. R. Phené Spiers. Revised illustrations with explanatory notes. 2500 w. Jour Roy Inst of Brit Archs—Jan. 29, 1898. No. 18688 B.

Renaissance.

Humanist Architecture in England. Paul Waterhouse. Review of and abstracts from a recent book—"A History of Renaissance Architecture in England" by Reginald Blomfield, which is most favorably considered. Ill. 2400 w. Jour Roy Inst of Brit Archs—Jan. 8, 1898. No. 18113 B.

Renaissance Woodwork in England. J. Hungerford Pollen. Explains the meaning of the

word "renaissance" and its application to the subject, discussing the work from the point of view of the architect. Discussion. 7000 w. Jour Soc of Arts—Feb. 11, 1898. No. 18495 A.

The Italian Renaissance. The first Royal Academy lecture on architecture this session, delivered by George Aitchison. Introductory remarks on early renaissance architects, and some of the work done by them. 3500 w. Builder—Feb. 5, 1898. No. 18392 A.

The Italian Renaissance. George Aitchison. The second Royal Academy lecture on architecture this session. Gives interesting description of examples with special attention to the Venetian Renaissance. 4500 w. Builder—Feb. 12, 1898. No. 18492 A.

The Italian Renaissance. George Aitchison. The third Royal Academy lecture on architecture this session. Deals with the Florentine Renaissance, the architects, buildings and many matters of interest. 3800 w. Builder—Feb. 19, 1898. No. 18733 A.

Scaffolding.

History of Early Scaffolding. W. J. Eden Crane. Reviews what is known of methods used in early times for the raising of high structures. Ill. 2000 w. Ill Car & Build—Feb. 18, 1898. No. 18689 A.

Theatres.

The Housing of the Drama. Edwin O. Sachs. Read at meeting of the Royal Institute of British Architects. Abstract. Treats of the aspects under which a playhouse devoted to the production of the drama could be constructed. Discussion. Ill. 3300 w. Builder—Feb. 12, 1898. No. 18493 A.

Training.

The Paris Training. John Galen Howard. A statement of what makes up the training in architecture in the course given in the Ecole des Beaux-Arts. 5500 w. Arch Rev—Vol. V.—No. 1. No. 18100 F.

Villa Fosca.

The Villa Fosca. Bertram Grosvenor Goodhue. An account of this interesting place on an island of the Adriatic. Part first is introductory, with some information of the gardens. Ill. 1100 w. Arch Rev—Vol V—No. 1. Serial. 1st part. No. 18099 F.

Wind Pressures.

The Measurement of Wind Pressures. Editorial on paper of Francis E. Nipher, communicated to the Academy of Science of St. Louis. 1200 w. R R Gaz—Feb. 25, 1898. No. 18666.

Wire Glass.

Recent Developments in the Manufacture and Applications of Wire-Glass. Francis Schumann. Its principal uses, and fire-resisting qualities. Ill. 1800 w. Jour Fr Inst—Feb., 1898. No. 18264 D.

Woodwork.

Polishes and Varnishes for Woodwork in Building. H. C. S. Gives ingredients and methods of preparation for a number of stains, varnishes, &c. 1200 w. Ill Car & Build—Jan. 28, 1898. No. 18235 A.

CIVIL ENGINEERING.

BRIDGES.

Bridges.

Three Noteworthy Foreign Bridges. (Drei Bemerkenswerthe Brückenbauten des Auslandes.) M. Foerster. A descriptive comparison between the Franz-Josephs Bridge at Budapest, the Alexander III Bridge at Paris, and the new arch bridge at Niagara. 4500 w. *Stahl und Eisen*—Feb. 1, 1898. No. 18571 D.

Caisson.

Pneumatic Caisson, Alexander III. Bridge. Condensed from the *Paris Génie Civil*. Describes the erecting and sinking of probably the largest caisson ever used. 900 w. *Eng Rec*—Feb. 26, 1898. No. 18671.

East River Bridge.

New East River Bridge. Important details and portions of the specifications for the bridge to be built between Delancey Slip, New York, and South Fifth Street, Brooklyn. 1500 w. *R R Gaz*—Feb. 11, 1898. No. 18330.

The Towers and End Spans for the New East River Bridge. Illustrations reproduced from the engravings accompanying the specifications from which selected information is given of interest in connection with the drawings. 3500 w. *Eng News*—Feb. 17, 1898. No. 18461.

Foundations.

The New East-River Bridge Foundations. Illustrates plant and methods of work. 2000 w. *Eng Rec*—Feb. 5, 1898. No. 18213.

Girder Riveting.

Field Riveting a Plate-Girder Span. Illustrates rapid methods of riveting with pneumatic tools, operated by a locomotive air-pump. 700 w. *Eng Rec*—Feb. 19, 1898. No. 18633.

Girders.

Plate-Lattice Girders. Discusses plate-lattice girders and compares them with the solid-sided girders, and doubts their being more economical. 2000 w. *Engr, Lond*—Jan. 21, 1898. No. 18115 A.

Portal Construction Applied to Girder Work. Illustrates a novel Belgian bridge. 1100 w. *Feb. 26, 1898. No. 18669.*

Park Bridges.

Cleveland Park Bridges. Illustrates and describes the new bridges which were designed with a special view to æsthetics. 1200 w. *Eng Rec*—Feb. 26, 1898. No. 18667.

Viaducts.

The Masonry of the New Viaducts over the Seine. (Exécution de Maçonneries des Nouveaux Viaducs sur la Seine.) Description of the new bridges over the Seine on the line of the Western Railway of France between Paris and Havre, with especial reference to the piers of truss bridges and the masonry work of stone arches as well as pneumatic foundations. Two articles, two plates. 6000 w. *Le Génie Civil*—Jan. 8, 15, 1898. No. 18505 G.

CANALS, RIVERS AND HARBORS.

Afforestation.

The Significance of Afforestation in Preventing and Correcting Torrents. F. Fankhauser. Address delivered before the Bern Forestry Assn. Considers forestation the only lasting remedy, the one nature herself applies when not interrupted by man, and discusses the subject in full. 3300 w. *Indian Forester*—Dec., 1897. No. 18206 D.

Aqueduct.

Reconstruction of the Hessen Aqueduct. Illustrated account of the substitution of structural work for heavy masonry construction in Alsace-Lorraine. 800 w. *Ry & Engng Rev*—Feb. 12, 1898. No. 18364.

Canal Depth.

The Economic Depth for Canals of Large Traffic. Joseph Mayer. Showing that the question has not been settled, and noting the points needing to be determined before it can be decisively answered. 4400 w. *Pro Am Soc of Civ Engs*—Feb., 1898. No. 18645 F.

Dams.

Movable Dams. B. F. Thomas. Valuable information on this subject with a description of the needle dam recently completed on the Big Sandy River at Louisa, Ky., and urging the construction of movable dams of higher lift on American rivers. Ill. 57500 w. *Pro Am Soc of Civ Engs*—Feb., 1898. No. 18646 F.

Drainage.

The Drainage Works of the Delta of the Niemen. (Travaux d'Epuisement du Delta du Niemen.) An illustrated account of the steam and electric drainage plant. Power is distributed electrically to a number of points where electric motors operate large scoop wheels. 3500 w. *Le Génie Civil*—Jan. 29, 1898. No. 18512 D.

Dredging.

Cost of Dredging in the United States. Tables compiled for the Nicaragua Canal Commission by T. Jenkins Hains. Also Cost of Concrete in the United States. 2500 w. *Eng News*—Feb. 17, 1898. No. 18458.

Dry-Docks.

The Brooklyn Dry-Dock Failure. A history of the dock which failed to hold water. 2000 w. *Eng Rec*—Feb. 19, 1898. No. 18632.

Erie Canal.

The Future of the Erie Canal. Explains the legal aspect of canal improvements. 700 w. *Eng Rec*—Feb. 5, 1898. No. 18212.

Harbor Improvements.

Harbor Improvement and Water Service at Portsmouth, Eng. The proposed improvement of the harbor railway terminus and the establishment of a better service by water between Portsmouth and Gosport. 1800 w. *Transport*—Feb. 4, 1898. No. 18389 A.

The Harbor Works at Fraserburgh. Describes

a scheme of harbor development and extension now in progress at this point. Ill. 3000 w. Transport—Jan. 21, 1898. No. 18158 A.

Naval Civil Engineers.

Some Lessons of the New York Naval Dry-Dock Failure. An editorial on the difficulties under which the naval civil engineers work. 2000 w. Eng Rec—Feb. 12, 1898. No. 18358.

The Bureau of Yards and Docks, U. S. Navy Department. An editorial explanation of the cause of poor civil-engineering work in the navy yards. 1000 w. Eng Rec—Feb. 19, 1898. No. 18630.

N. Y. State Canals.

The Condition of the New York State Canals. Illustrates the old and new work. 500 w. Eng Rec—Jan. 29, 1898. No. 18146.

River Banks.

The River Bank Protection Works for the Bukowina Local Railway. (Die Uferschutzbauten bei den Bukowinaer Localbahnen.) R. Ziffer. An excellent account of the effective methods used for protecting the banks of mountain torrents in the Carpathians. Two plates. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1898. No. 18561 D.

River Improvement.

The Proposed Improvement of the Mouth of the Mississippi. From the New Orleans *Daily Picayune*. Abstract of arguments submitted by committee in connection with a proposed deeper channel at the entrance of the river. 900 w. Eng News—Feb. 24, 1898. No. 18656.

Ship Canal.

The Opening of the Ship Canal through Breslau, and the Canalisation of the Upper Oder to Kosel. (Die Eröffnung des Grossschiffahrtsweges durch Breslau und die Canalisirung der Oberen Oder bis Kosel.) With maps showing the location of the work and data concerning its commercial importance. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 4, 1898. No. 18542 B.

Towing.

Cable Towing. (Halage Funiculaire.) A brief abstract of the application of continuous cable towage on the Aisne and Marne Canal, in the north of France. 1200 w. Comptes Rendus—Jan. 10, 1898. No. 18518 D.

IRRIGATION.

India.

The Palar Anicut System. General plan of the head works and a cross-section of the Anicut, giving particulars of interest to the irrigation engineer. 900 w. Ind Engng—Dec. 25, 1897. No. 18111 D.

Water-Rights.

The Adjudication of Water-Rights in Irrigated Regions. Elwood Mead. Discusses the differences in ownership between water-rights and other property, and advocates individual operation under public ownership as the solution of the problem. 4000 w. Engineering Magazine—March, 1898. No. 15898 B.

MISCELLANY.

Ancient Engineers.

The Engineers of the Past. Perry F. Nursey. A brief comparison and review of the works of the ancient engineer. 1800 w. Ind & Ir—Feb. 11, 1898. No. 18485 A.

Beams.

The Efficiency of Built Up Wooden Beams. Edgar Kidwell. The experiments described were made in the mechanical laboratory of the Michigan College of Mines, with the object of obtaining data upon the relative efficiency of various forms. Ill. 19000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18475 D.

The Flexure of Thick Beams. (Sur la Flexion des Pièces Epaissees.) M. Ribière. A mathematical discussion, showing that when the depth of a beam is greater than one-tenth of its length, the stresses at various points of the section depart from the usual trapezoidal law, and are indicated by curves rather than straight lines. 1800 w. Comptes Rendus—Jan. 31, 1898. No. 18525 D.

Cement.

Portland Cement Tests from the Manufacturer's Point of View. John W. Dickinson. On the value of testing and some of the methods, and its importance to the reliable manufacturer. 1400 w. Munic Engng—Feb., 1898. No. 18122 C.

Silico-Portland Cement. (Le Silico-Portland ou Silico-Cement.) A fully illustrated article upon the manufacture of the improved cement in which a portion of finely ground sand is mixed with the cement. The strength is greatly increased by the more intimate union of the constituents. 5000 w. La Revue Technique—Jan. 25, 1898. No. 18526 D.

The Hardening Process of Calcareous Hydraulic Cements. W. Michaelis. Read before the Society for the Unification of Methods of Testing Technical Materials at Stockholm. A careful study of the process of hydraulic hardening. 4200 w. Engng—Feb. 4, 1893. No. 18373 A.

The Proper Manipulation of Tests of Cement. A copy of questions sent out by committee appointed to report on this subject. 7200 w. Am Arch—Feb. 19, 1898. No. 18616.

Corrosion.

The Corrosion of Iron in Concrete. A summary of information that has been published on this subject. Part first gives abstract of paper by G. Bouscaren on the Covington and Cincinnati suspension bridge, and also of the discussion. 2500 w. Eng Rec—Feb. 19, 1898. Serial. 1st part. No. 18634.

The Corrosion of Iron in Concrete. A symposium on the subject by several engineers and architects, in continuation of information given in this paper, Feb. 19. 1100 w. Eng Rec—Feb. 26, 1898. No. 18668.

Framework.

See Architecture and Building, Construction.

Landslides.

See Railway Affairs, Permanent Way.

Monier System.

See Architecture & Building, Construction.

Netherlands.

Engineering in The Netherlands. H. A. Van Ysselsteyn. Historical and descriptive account of machinery used for keeping dry the lands lying lower than the surface of the sea. Ill. 2000 w. Power—Feb., 1898. No. 18200.

Roads.

A Few Things to be Remembered in Building Good Roads. William H. Barnes. The importance of good drainage and having the bed well prepared, pointing out some of the more common faults in road building. 1700 w. Stone—Feb., 1898. No. 18439 c.

New Jersey State Roads. A review of the successful and satisfactory law regulating state road-work. 2000 w. Eng Rec—Feb. 19, 1898. No. 18636.

Roof.

See Architecture & Building, Construction.

Shield Tunneling.

Shield Tunneling for the Boston Subway. Illustrates in detail the operations involved in constructing this hydraulic roof-shield. 900 w. Eng Rec—Feb. 26, 1898. No. 18670.

Steel Construction.

See Architecture & Building, Construction.

Surface Drainage.

Dimensions of Channels for Surface Drainage. Charles Edward Livesay. Reprinted from the Minutes of Proceedings Inst. C. E. Formulates

a theory and describes its application in actual practice in India. 5000 w. Engng—Feb. 11, 1898. No. 18481 A.

Surveying.

Dialling Troubles and Their Treatment. Arthur Mort. Remarks on the troubles which beset the dialler in his work. 1500 w. Col Guard—Jan. 21, 1898. No. 18140 A.

Telemeters.

A Diagram for the Reduction of Telemeter Readings. Neville B. Craig. States facts showing the difficulty and labor of all methods of obtaining accurate results in topographical work, and explains the use of a diagram, constructed by the writer, which has given more satisfactory results than any device he has tried. It is simple, rapid and comparatively inexpensive. 2000 w. Eng News—Feb. 3, 1898. No. 18202.

Timber Preservation.

The Haskin Process of Preserving Timber. Account of the plant and description of process. Ill. 2400 w. Engr, Lond—Jan. 28, 1898. No. 18276 A.

Time.

The System of Decimal Time. (Sur la Systeme de l'Heure Decimale.) An abstract of a report upon the decimal subdivision of the hour, with its relations to the divisions of the day and the circle, presented to the French Academy by M. D. Sarranton. 1500 w. Comptes Rendus—Jan. 17, 1898. No. 18520 D.

Wind Pressures.

See Architecture & Building, Miscellany.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Commerce.

Our Foreign Business in 1897. Facts taken from the import and export returns published by the United States Bureau of Statistics. 1400 w. Ir Age—Feb. 24, 1898. No. 18640.

The Foreign Commerce of the United States in 1897. Table giving a summary of the imports and exports by customs districts for all ports where the volume of either incoming or outgoing business in 1897 was in excess of \$400,000. 400 w. Eng News—Feb. 24, 1898. No. 18657.

Cheap Transportation.

Railroads versus Canals. J. A. Latcha. Arguments against canal building, especially the Nicaragua canal, and urging the development of railroads, and lessening the cost of operation, enabling the commodities of the United States to be delivered in Europe and Asia, at prices that would undersell the world. 7500 w. N Am Rev—Feb., 1898. No. 18183 D.

China.

America's Interests in China. James H. Wilson. Some information of the country, people, and government given to make clear the commercial and diplomatic interests of the United

States. 5000 w. N Am Rev—Feb., 1898. No. 18181 D.

Great Britain's Opportunity in China. C. A. Moreing. On the decision of the British Government to guarantee a loan of £12,000,000 sterling to China, at 3 per cent. interest and the importance of the event. The terms are discussed. 3200 w. Nineteenth Cent—Feb., 1898. No. 18425 D.

Our Trade with Western China. John Foster Fraser. The writer is one of the three cyclists who have crossed China from Burma to Shanghai. Matters concerning British trade and the best points for its introduction. 2800 w. Contemporary Rev—Feb., 1898. No. 18287 D.

United States Trade with China. Additional details relating to Kiao-Chow Bay. Also table showing that the United States trade has made great advancement. 600 w. Cons Reps—Feb. 5, 1898. No. 17706 D.

Eastern Trade.

German versus British Trade in the East. Clavell Tripp. Considers the British need have no fears in regard to retaining their commercial supremacy, giving reasons based on personal experience during long residence in Sumatra. 2200 w. Nineteenth Cent—Feb., 1898. No. 18423 D.

Germany's Trade with Eastern Asia. Infor-

mation of German exportation during 1896. 400 w. Cons Reps—Feb. 10, 1898. No. 18341 D.

Opportunities in the East. Editorial discussion of the openings for trade and industry in Japan and China. 1200 w. Mach, Lond—Feb. 15, 1898. No. 18648 A.

Economic Changes.

The Distribution of Manufacturing Industries. Calls attention to changes in progress due to modern inventions and the spread of civilization, carrying manufacturing industries all over the world, tending to bring together the factory and the raw material and diminishing local advantages. 1700 w. Eng News—Feb. 10, 1898. No. 18321.

Free Trade.

The Manchester School and To-Day. Andrew Carnegie. Explains the position as outlined by the Manchester School, and the changed conditions, and development of the industrial world. 3000 w. Nineteenth Cent—Feb., 1898. No. 18424 D.

German Exports.

German Exports to the United States, 1897. A comparative statement of the exports during 1896 and 1897. 1200 w. Cons Reps—Feb. 19, 1898. No. 18606 D.

Great Lakes.

Commerce of the Great Lakes. The development of trade on the great American lakes, the works of improvement in facilities for travel, and the immense traffic. 1800 w. Sci Am—Feb. 19, 1898. No. 18418.

Japan.

Japanese Trade with Britain. Gives some suggestions of Mr. Arakawa, the consul for Japan in London, made to indicate how the Japanese may improve their conditions of trade. 700 w. Engng—Feb. 11, 1898. No. 18478 A.

The Condition of Trade with Japan. Editorial on the report of Bryan Brenan, who was sent to investigate the condition of trade. 2300 w. Engng—Jan. 28, 1898. No. 18267 A.

The Shipping Industry in Japan. Editorial on the condition of this industry with criticism of the methods of doing business. 1500 w. Engng—Jan. 21, 1898. No. 18132 A.

Omaha Exposition.

The Great Exposition at Omaha. Charles Howard Walker. The plan of the grounds, character of the buildings, and matters of general interest. Ill. 2000 w. Century Mag—Feb., 1898. No. 18124 D.

Prices.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Tabulated statements, showing fluctuations in quotations from Jan. 1, 1895, to Feb. 1, 1898. 20000 w. Bradstreet's—Feb. 12, 1898. No. 18355.

What Determines Prices? Considers different theories of value, and defends the doctrine that economic value is determined by the cost of production rather than by the mere ratio between supply and demand. 3000 w. Gunton's Mag—Feb., 1898. No. 18209 C.

Rubber.

Has There Been Speculation in Rubber? The opinions of rubber men on this subject, suggested by the persistency with which the prices of crude rubber rise in the face of a full production. 2500 w. Ind Rub Wld—Feb. 10, 1898. No. 18430 D.

The Crude India-Rubber Trade of 1897. Statistics for the year are given with comments. 1200 w. Ind Rub Wld—Feb. 10, 1898. No. 18431 D.

Russia.

Russian Industry and Trade. Calling attention to the economic and industrial development which is taking place in this country. 1800 w. Engng—Feb. 4, 1898. No. 18372 A.

The Influence of the Great Siberian Railway upon Russian Industries. The outlook resulting from the development of the vast resources of Siberia, and their importance to the United States. 1100 w. Ir Age—Feb. 10, 1898. No. 18315.

Trade with Russia. Editorial review of Mr. Mitchell's opinions concerning the industrial resources and prospects of the Russian Empire. 1000 w. Mach, Lond—Feb. 15, 1898. No. 18649 A.

Statistics.

Credit and Trade. A. Sauerbeck. A review of the position of credit and trade during the past year, largely confined to British interests. 3500 w. Bankers' Mag, Lond—Feb., 1898. No. 18426 F.

Credit and Trade in the United States and Canada. A review of the past year. 1800 w. Bankers' Mag, Lond—Feb., 1898. No. 18427 F.

World's Commerce.

A French View of the World's Commerce. Statement made by Jules Roche, in an address to a conference of the merchants and bankers of Lyons, Fr., regarding the importance, as exporters of England, Germany, the United States, and France. 300 w. Cons Reps—Feb. 8, 1898. No. 18233 D.

CURRENCY AND FINANCE.

Currency.

Currency Reform. Robert S. Taylor. States the declaration of principles of the Indianapolis convention, the events that led to this action, and the work of the Monetary Commission. 3400 w. Century Mag—Feb., 1898. No. 18126 D.

The New Indian Currency Measure. Reviews the steps already taken by the India Government in the direction of currency reform, and considers the measures recently proposed by the Council. 2500 w. Bankers' Mag, Lond—Feb., 1898. No. 18428 F.

Monetary Commission.

The Monetary Commission and Its Work. Charles S. Fairchild. An account of the conditions that caused the appointment of this commission, the work done, and the points considered. 5000 w. N Am Rev—Feb., 1898. No. 18182 D.

Russia.

The Gold Standard in Russia. Reprint of an article in a Russian paper regarding the change in Russia's currency. 800 w. Cons Repts—Feb. 10, 1898. No. 18342 D.

GOVERNMENTAL CONTROL.**Commerce Regulation.**

The Proposed Changes in the Law to Regulate Commerce. Milton H. Smith. The objections of the writer to the proposed changes relating to the long and short haul. Also editorial. 3000 w. Ry & Engng Rev—Feb. 19, 1898. No. 18629.

See Railway Affairs, Legal.

Municipal Ownership.

See Street & Electric Tramways.

Ownership.

See Railway Affairs, Legal.

Protection.

Equitable Protection. Debate between David Lubin and John E. Russell before the New England Free Trade League. 12500 w. New Eng Free Trd League, Boston—No. 7 of 1897. No. 18429 D.

Socialism.

See Electrical Engineering, Lighting.

LABOR.**Compensation.**

Compensation to Workmen. A. D. Provand. Gives a brief history of what has been done in England to compensate workmen for injuries sustained. Discussion. 8500 w. Jour Soc of Arts—Feb. 11, 1898. No. 18496 A.

Workmen's Compensation Act and Employers' Liability. Discussion of a new Act which will come into operation in England, July 1, 1898. Gives a summary of the Act with explanations and comments. 6300 w. Ill Car & Build—Jan. 28, 1898. No. 18236 A.

Engineering Strike.

Some Lessons of the Great Strike. Considers that the men should be taught the need of moderation, of wise leadership, of a wider outlook, of securing public sympathy; that the employers should be taught the need of up-to-date systems of working, of moderation, and of better relationships with their workers. 2800 w. Elec, Lond—Feb. 4, 1898. No. 18336 A.

The Crisis in the Engineering Dispute. Editorial on the apparent approaching end of this labor struggle, showing the present attitude of masters and men. 3000 w. Engng—Jan. 21, 1898. No. 18133 A.

The End of the War. Remarks on the apparent defeat of the Amalgamated Society of Engineers, and on the mistakes made and changes required. 3000 w. Engr, Lond—Jan. 28, 1898. No. 18277 A.

The Resumption of Work. Editorial on the conditions the workmen must meet on their return to work. 1800 w. Engng—Feb. 4, 1898. No. 18371 A.

Exhibits.

Social Economy Exhibits at Brussels. This

class of exhibits comprised all that relates to teaching and apprenticeship, the organization of labor, the safeguarding and regulation of labor, labor economics, &c., &c. An account of some of the exhibits is given in part first. 2000 w. Engng—Feb. 4, 1898. Serial. 1st part. No. 18369 A.

Immigrant.

A Typical Alien Immigrant. Arnold White. A reply to an article in the last number of this magazine, by John A. Dyche. 4600 w. Contemporary Rev—Feb., 1898. No. 18288 D.

Labor Discussion.

The Engineers' Dispute. Reports a discussion of the recent strike and lockout in England, at a gathering of the members of the United Club, held at the Criterion. 4500 w. Engr, Lond—Feb. 11, 1898. No. 18483 A.

Labor Statistics.

Recent Foreign Labor Statistics. Brief report of items, selected from various sources, relating to the labor conditions of the Netherlands, France, Belgium, and Russia. 1800 w. Gunton's Mag—Feb., 1898. No. 18210 C.

Prison Labor.

Labor in Russian Prisons. C. D. Randall. Some information of prison life in Russia, including Siberia. 2200 w. State's Duty—Jan., 1898. No. 18127.

Protection.

Labor's Interest in Protection. Henry Smith Robinson. Shows what would be the effect of adopting free trade, and that protection is necessary to the prosperity of the laborer. 2500 w. Gunton's Mag—Feb., 1898. No. 18208 C.

Trade Unions.

Trade Unions in 1896. Interesting information culled from the Ninth Report on Trade Unions in Great Britain. 1800 w. Jour Gas Lgt—Feb. 8, 1898. No. 18440 A.

MISCELLANY.**Discontent.**

Some Pressing Problems. A. H. McKnight. Notices the tariff, ownership of land, the monetary system, socialism, &c. 2300 w. Gunton's Mag—Feb., 1898. No. 18211 C.

Education.

Technical Education in Sweden. (Das Technische Unterrichtswesen Schwedens.) Th. Beckert. A very full account, showing the extent and high character of the technical educational work done in Sweden and Norway. 7500 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1898. No. 18552 D.

England.

England's Economic and Political Crisis. J. N. Larned. An interesting study of the conditions which have affected the development of England, and the causes that have operated to diminish the economic capability in production and trade. 8500 w. Atlantic M—March, 1898. No. 18608 D.

Fish Products.

Oil and Guano from Fish. (L'Huile et le

Guano de Poisson.) Discussing the technological applications of fish oil, and the use of the residues as a fertilizer. 2000 w. *Le Génie Civil*—Jan. 1, 1898. No. 18504 D.

Patents.

Prior Foreign and Later United States Application for Patent on the Same Invention. D. Walter Brown. Discussing the amendments to the patent statutes that went into effect Jan. 1, 1898, in the United States. 700 w. *Am Mach*—Feb. 17, 1898. No. 18435.

The Important Features of the New Austrian Patent Law. (*Die Wichtigsten Bestimmungen des neuen Oesterr. Patent-Gesetzes.*) An abstract of the salient features of the law of January 11, 1897, referring both to patents and trade marks. 4000 w. *Oesterr Zeitschr f Berg u*

Hüttenwesen—Jan. 29, 1898. No. 18575 B.

Prizes.

Programme of Prizes Offered by the French Academy. (*Programme des Prix Proposés pour les Années 1898, 1899, 1900, et 1901.*) Giving the value and conditions of competition of the many prizes offered by the French Academy for the next four years in various departments of scientific research. 10000 w. *Comptes Rendus*, Jan. 10, 1898. No. 18519 D.

Silk.

Silk and Silk-Worms in China. A report upon silk cultivation and preparation, and upon the raising and care of silk-worms as conducted in the province of Szechuen. 2000 w. *Cons Repts*—Feb. 21, 1898. No. 18607 D.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bleaching.

The Electrolytic Decomposition of the Chlorides of Sodium and Magnesium. M. C. Beebe. Abstract of a thesis submitted at the Univ. of Wisconsin. Also editorial. An account of investigations and experiments to ascertain under what conditions a bleaching solution can be economically prepared, and thus determining whether electrolytic bleaching can compete with the chemical methods. 6500 w. *Elect'n*, Lond—Jan. 21, 1898. No. 18110 A.

Electrolysis.

Concerning Hydrolysis and Catalysis. (*Ueber Hydrolyse und Katalyse.*) G. Platner. Discussing the experiments of Warburg, Paschen, and Jahn, concerning the hydrolytic dissociation of various salts. 3000 w. *Elektrochemische Zeitschr*—Jan., 1898. No. 18587 D.

Ore Treatment.

Notes on the Electro-Chemical Treatment of Ores Containing the Precious Metals. C. E. Webber. Read before the British Institution of Electrical Engineers. Historical review of the various known processes is given in part first. Ill. 2400 w. *Ind & Ir*—Jan. 28, 1898. Serial. 1st part. No. 18280 A.

Progress.

Electro-Chemistry's Advance. Inaugural address of J. W. Swan before the British Inst. of Elec. Eng's., on the progress of electro-chemistry and the industries and applications. 3000 w. *Engng*—Jan. 21, 1898. Serial. 1st part. No. 18142 A.

Review.

Electrochemistry in 1897. (*Die Elektrochemie im Jahre 1897.*) Dr. H. Weyer. A very full review of the progress of electro-chemistry during the past year, with numerous references to periodical literature. 6000 w. *Elektrochemische Zeitschr*—Jan., 1898. No. 18588 D.

White Lead.

Some Electrolytic Processes for the Manufacture of White Lead. Sherard Cowper-Coles.

Describes the Dutch process, which is still considered the best as regards its covering capacity and also describes briefly several electrolytic processes. 1300 w. *Elec Rev*, Lond—Feb. 11, 1898. No. 18487 A.

Zinc.

Electrolytic Zinc. A review of the processes used and comments on the cost. 1200 w. *Engng*—Jan. 21, 1898. No. 18136 A.

LIGHTING.

Baltimore, Md.

The System of the Brush Electric Company of Baltimore. Illustrated description of the rebuilt station, which is one of the most complete and systematically arranged in the country. 1300 w. *Elec Wld*—Feb. 26, 1898. No. 18624.

Carbons.

Carbons for Electric Lighting and Other Purposes. Francis Jehl. From a forthcoming book to be published by the *Electrician*. Part first considers the physical properties of carbon, and gives historical notes on uses. 3000 w. *Elect'n*, Lond—Feb. 4, 1898. Serial. 1st part. No. 18401 A.

Fluorometer.

The Fluorometer. Describes and illustrates an instrument used to establish with precision the location of any foreign object within the human organism, which is comparatively impermeable to the X-rays. 1500 w. *Sci Am*—Feb. 12, 1898. No. 18307.

Generating Unit.

A Compact Electric Generating Unit. Illustrated description of a machine just installed in the Twelfth Street Station of the Edison Electric Illuminating Co., New York. 2000 w. *Power*—Feb., 1898. No. 18199.

Glow Lamps.

Experiments on the Glow Lamp. Hiram S. Maxim. From *London Lighting*. On the experiments of the writer who claims that he can save from 25 to 33 per cent. 800 w. *Elec Rev*, N. Y.—Feb. 2, 1898. No. 18168.

House Wiring.

Technical Litigation and the Question of Good Work in House Wiring. V. Zingler. Part first considers technical litigation demonstrating that the law is not a fit or proper instrument for deciding these cases on their merits, nor the Law Courts the place for referring the cases. 2000 w. Elec Rev, Lond—Jan. 28, 1898. Serial. 1st part. No. 18290 A.

Nottingham.

Nottingham Electricity Works. Illustrated detailed description. 2200 w. Elec Eng, Lond—Feb. 11, 1898. No. 18488 A.

Socialism.

Municipal Socialism. Fred. De Land. Read before the Northwestern Electrical Assn. Statements concerning electric lighting in Des Moines, Ia., also in Detroit, Topeka, and Allegheny City, and an examination of the question whether the mayor of the first named city was justified in fixing \$75 per year for each arc lamp of 2000 candle power. 1600 w. Elec Eng, N. Y.—Feb. 10, 1898. No. 18306.

Stage Lighting.

The Switchboard for Stage Lighting. H. Bissing. Some suggestions of points worth considering in the arrangements for stage lighting. 800 w. Elec Wld—Feb. 19, 1898. No. 18422.

Station Destroyed.

Destruction of an Electric Lighting Sub-station in Montreal. An account of the destruction of the sub station at Côte Ste. Paul, Montreal, belonging to the Lachine Rapids Hydraulic and Land Co. Ill. 500 w. Elec Wld—Feb. 19, 1898. No. 18421.

Wiring.

Interior Wiring. Charles E. Knox. Part first is introductory presenting and discussing the methods and practices in vogue at the present day. The serial will include detailed plans for wiring all classes of buildings. 2500 w. Am Elect'n—Feb., 1898. Serial. 1st part. No. 18242.

Merchant-Marine Wiring. E. W. Countiss. Pointing out the precautions that must be taken to avoid fire risks. Ill. 1500 w. Am Elect'n—Feb., 1898. No. 18243.

POWER.**Boosters.**

See Street and Electric Tramways.

Central Stations.

Topics of Interest to Central Station Men. F. B. Badt. Address delivered before the Northwestern Elec. Assn., Milwaukee. Discusses 220-volt lamps, enclosed arc lamps, alternating system, etc. 2200 w. W Elect'n—Jan. 29, 1898. No. 18153.

Coal Mining.

See Mining and Metallurgy, Coal and Coke.

Compound Dynamos.

The Parallel Operation of Compound Dynamos. George T. Hanchett. Explains an arrangement for overcoming the difficulty arising

in the operation of compound dynamos in multiple because of their failure to regulate for line loss with accuracy. Ill. 1700 w. Elec Wld—Feb. 12, 1898. No. 18303.

Electricity in Mills.

Electricity in Cotton Mills. A letter from W. B. Smith Whaley on the advantages of electric operation. 1200 w. Eng Rec—Feb. 12, 1898. No. 18361.

Electric Lifts.

Electric Lifts and Cranes. Abstract of the discussion of a paper by H. W. Ravenshaw, read at meeting of British Inst. of Civ. Eng. 7000 w. Col Guard—Jan. 21, 1898. Serial. 1st part. No. 18139 A.

Electric Motors.

The Electric Motor at Home. An illustrated account of a few of the uses made of these motors in the shops of the General Electric Company, at Schenectady, N. Y. 1500 w. Ir Age—Feb. 3, 1898. No. 18171.

Electric Welding.

The Electrically Welded Rail. Hunter Morrison. Brief historical review of this work, with table showing energy absorbed in electric welding. Ill. 1200 w. Yale Sci M—Jan., 1898. No. 18311 C.

Grain Elevator.

The Great Northern Elevator. Albert Vickers. Illustrated description of a fine, large grain elevator in Buffalo, N. Y., operated by electric power. 2500 w. Elec Wld—Feb. 12, 1898. No. 18302.

Locomotive.

See Railroad Affairs, Motive Power.

Montana.

The Montana Power Company. L. D. Tandy. Illustrated detailed description of a plant that will rank among the finest in the United States, from both an engineering and from a financial standpoint. 2000 w. St Ry Jour—Feb., 1898. No. 18194 D.

Motor Design.

Electric Motor Design for Ordinary Street Railways. E. C. Sickles. Considers some of the problems connected with the design of the electric motor for street-railway service. Part first gives a brief review of the main causes of present practice. 3800 w. Sibley Jour of Engng—Feb., 1898. Serial. 1st part. No. 18610 C.

Newspaper Presses.

Electrical Control and Operation of Newspaper Presses in the News and Record Office, Chicago. Describes the methods adopted. 1500 w. Elec Eng, N. Y.—Feb. 24, 1898. No. 18642.

Paper Making.

Use of Electric Motors in Paper Making. Louis Bell. Extract from a paper read before the New York meeting of American Paper and Pulp Assn. aiming to show the reduction in cost of power, and other advantages. 2000 w. Elec Wld—Feb. 26, 1898. No. 18625.

Power Development.

The Electric Development of Hydraulic Power.

F. C. Finkle. With especial reference to the development of water powers in southern California, giving many illustrations of power locations. 4000 w. Engineering Magazine—March, 1898. No. 18599 B.

Power Plant.

Hydraulic Electric Power at Moutier-Grandval, Switzerland. (Installation Hydro-Electrique de Moutier-Grandval, Suisse.) An interesting power plant near Basle. The flow of the river Birse is only about 21 cu. ft. per second, but a head of over 300 feet enables 500 h. p. to be developed and applied in this industrious community for lighting and power. 5000 w. 1 plate. Le Génie Civil—Jan. 1, 1898. No. 18503 D.

The Distribution of Electric Energy at Schwyz, Switzerland. (Distribution d'Energie Electrique de Schwyz.) An excellent account of this new power plant on the lake of Lucerne. Over 3000 h. p. are taken from the river Muota and distributed both for lighting and power. 1 plate. 5000 w. Le Génie Civil—Feb. 5, 1898. No. 18514 D.

The Electric Plant of the Paris Compressed Air Company. (Les Nouvelles Installations Electriques de la Compagnie Parisienne de l'Air Comprimé.) A fully illustrated description of the fine new power house on the Quai de Jemmapes, with details of the construction of the buildings, steam and electric plant. Two articles. Four plates. 10000 w. Le Génie Civil—Dec. 18, 25, 1897. No. 18500 G.

Shop Transmission.

Electrical Shop Transmission. H. G. Dimick. Read before the Chicago Elec. Assn. Describes a plain two-wire 220-volt system, and motors belted to line shafting in the various departments of the shop in question. 2700 w. W Electn—Jan. 29, 1898. No. 18152.

Starting.

Concerning Starting and Reversing Resistances for Shunt Motors. (Ueber Anlass- und Umkehr-Anlasswiderstände für Nebenschlussmotoren.) E. Egger. Describing a system of magnet winding intended to increase the starting torque and diminish sparking. The method is fully shown by diagrams. 4000 w. Elektrotech Zeitschr—Feb. 3, 1898. No. 18584 B.

Transmission.

Electric Transmission Plant at Juiz de Fora, Brazil. Percy H. Thomas. Describes a rather immense plant supplied by an American manufacturing company. Ill. 2200 w. Elec Wld—Feb. 19, 1898. No. 18420.

Some Transmission Practices. Considers synchronizing two phases, changing insulators on live lines, a prony brake experiment, a novel lightning arrester, &c. Ill. 5200 w. Jour of Elec—Jan., 1898. No. 18265.

The Transmission Plant of the Apple River Power Company. A long distance plant is illustrated and described. 1800 w. Elec Wld—Feb. 5, 1898. No. 18224.

Wave Power Generator.

Morley Fletcher's Wave-Power Electric Buoy. Describes and illustrates a beacon light, and launch-charging buoy. Terminals are provided at the side of the buoy, so that an electrical

launch may be moored and receive its charge of electrical energy when desired. 1600 w. Ind & Ir—Feb. 4, 1898. No. 18388 A.

TELEGRAPHY AND TELEPHONY.

Current.

The Generation of Current in the Main Telegraph Office at Stuttgart. (Die Stromerzeugungsanlage in Stuttgarter Haupttelegraphenamts.) G. Ritter & J. H. West. An elaborate account of the use of accumulator batteries at the Stuttgart telegraph office. Three articles. 7500 w. Elektrotech Zeitschr—Jan. 27, Feb. 3, 10, 1898. No. 18583 G.

Detroit.

The Detroit Telephone Company. S. P. Grace. Illustrated detailed description of the plant with brief history of the company organization. 2500 w. Elec Eng, N. Y.—Feb. 3, 1898. No. 18175.

Home Telephone.

The Home Telephone Companies. Gives the history of the Home Companies in Baltimore, Newark, Jersey City, Atlanta, Trenton, Wilmington, &c. 8800 w. Elec Engng—Feb. 15, 1898. No. 18647.

Lightning Arrester.

Welles' Safety Fuse Lightning Arrester for Telephone Apparatus. (Blitzableiter-Abschmelzsicherung der Telephon-Apparat-Fabrik Fr. Welles.) An arrangement of carbon lightning conductors and fusible wire connections, to be used in connection with the station switchboard. 1000 w. Elektrotech Zeitschr—Jan. 20, 1898. No. 18578 B.

Pacific Cable.

The Pacific Cable. From the London Times. Discusses the importance of this work to Canada, and the renewed interest in the subject. 1500 w. Elec Eng, Lond—Jan. 21, 1898. No. 18161 A.

Submarine Cables.

A Submarine Cable Successfully Laid Under Difficulties. Illustrated account of the laying of the Fire Island cable of the Postal Telegraph Co.'s Marine-News Service. 1400 w. Elec Rev, N. Y.—Feb. 16, 1898. No. 18411.

The Great South Bay Postal Submarine Cable Successfully Laid by the Okonite Company. An illustrated account of the carrying out of the work. The cable is laid between Fire Island and Conklin's Point, and was one of the most difficult pieces of work recently laid on this side of the globe. 1200 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18446.

Submarine Conduit.

A 557-ft. Telephone Subway under the Harlem River, New York City. Illustrated description of the interesting features in the construction and launching of this conduit. 1200 w. Eng News—Feb. 17, 1898. No. 18459.

A Submarine Conduit. Describes the method of putting in place the conduit laid across the Harlem River at New York, for carrying the cables of the American Telephone and Telegraph Co. Ill. 600 w. Elec Wld—Feb. 19, 1898. No. 18419.

Telephone Exchange.

The Delmarvia Telephone Co.'s Exchange, Wilmington, Delaware. Illustrated description. 900 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18444.

The New Exchange of The Cleveland Telephone Co. Illustrated detailed description of the equipment of the new building. 1600 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18443.

Wireless Telegraphy.

The Future of Wireless Telegraphy. Charles R. Gibson. Does not think these methods will take the place of ordinary telegraphy, but thinks if an apparatus can be made practicable for use at sea or in warfare it will greatly benefit mankind. Ill. 1600 w. Elec, Lond—Feb. 4, 1898. No. 18337 A.

Wireless Telegraphy—A Forecast. J. Rees. Predicting great changes, socially, commercially, and economically from the success of this recent discovery. 1100 w. Elec Rev, Lond—Feb. 11, 1898. No. 18486 A.

MISCELLANY.**Accumulators.**

See Street and Electric Tramways.

Address.

Presidential Address of John S. Raworth before the Northern Society of Elec. Engs. of England. Deals with the problem of supplying electric power. 4000 w. Engng—Jan. 21, 1898. No. 18143 A.

Alloys.

The Calculations of the Electrical Resistances of Alloys and Their Application to the Finding of Alloys of Definite Electrical Properties. C. Liebenow. Read before the Elektrotechnischen Verein on Nov. 23, 1897. Part first consists of introductory remarks and a consideration of simple alloys. 1600 w. Elec, N. Y.—Feb. 9, 1898. Serial. 1st part. No. 18324.

Alternators.

Notes on Synchronizing Alternators. H. E. M. Kensit. Gives methods for ascertaining whether the synchronizing transformers are so connected that the alternators are in phase when the lamp is bright. Ill. 1500 w. Elect'n, Lond—Feb. 4, 1898. No. 18402 A.

Armatures.

Armature Connections and Diagrams. Arthur L. Rice. Part first deals with the process of winding and connecting in various forms of armatures. Ill. 1500 w. Am Elect'n—Feb., 1898. Serial. 1st part. No. 18238.

Capacity.

Measurement of Capacity with the Balance. (Messung von Kapacitäten mit der Waage.) An adaption of Lang's method, weighing the attraction between two copper spirals, one of which is connected with the condenser. 2000 w. Elektrotech Zeitschr—Jan. 20, 1898. No. 18579 B.

Conductors.

Aluminum as a Rival of Copper for Electrical Conductors. Alfred E. Hunt. Presenting the qualities of aluminum that show its adaptability

to this use, also the drawbacks. 1800 w. Elec Wld—Feb. 26, 1898. No. 18626.

Curve Tracer.

An Electric Curve Tracer. Edward B. Rosa. Discusses the value of methods of investigation by tracing the forms and phases of alternating-current curves, and the methods by which current curves have been drawn. An illustrated description of an apparatus for doing this work, which reduces the labor and increases the speed. 5200 w. Phys Rev—Jan., 1898. No. 18094 D.

Diagrams.

Conventional Electrical Diagrams. — The Chicago Electrical Association. Diagrams embodied in the report of the special committee, with statement of F. S. Hickok on the subject. 2000 w. Elec Eng, N. Y.—Feb. 24, 1898. No. 18643.

Dynamometer.

The Helmholtz Absolute Electrodynamometer. (Das Helmholtz'sche Absolute Elektrodynamometer.) Dr. K. Kahle. A very full and illustrated description of the Helmholtz dynamometer, which acts by measuring the turning moment between two bobbins. 7500 w. Elektrotech Zeitschr—Feb. 3, 1898. No. 18585 B.

Electrical Action.

See Architecture and Building, Miscellany.

Electrical Advance.

Electrical Advance in the Past Ten Years. Elihu Thompson. Abstract from *The Forum*. Review of progress made in different lines. 2000 w. Min Ind & Rev—Feb. 3, 1898. No. 18304.

Electric Heating.

See Architecture and Building, Heating.

Electrical Hypothesis.

An Electrical Hypothesis for the Solar and Planetary Systems, and Some of Their Associated Phenomenon. Gives an interesting hypothesis explaining the solar and planetary systems as the result of electrical energy. 2400 w. Elec Rev, Lond—Jan. 21, 1898. No. 18109 A.

Electrical Works.

The Siemens & Halske Works, at Charlottenburg, Germany. Robert Grimshaw. Illustrated description of some of the machines used in these works. 1800 w. Mach, N. Y.—Feb., 1898. No. 18299.

Films.

On the Electrical Resistance of Thin Films. Isabelle Stone. Investigations suggested by the discrepancy between the resistance of a film of given thickness measured directly by the Wheatstone bridge, as compared with the resistance calculated from its weight, density and dimensions. The metal studied is silver. 3500 w. Phys Rev—Jan., 1898. No. 18093 D.

Franklin.

Benjamin Franklin and His Electrical Experiments. Edward N. Saunders, Jr. Popular account of the early work of Franklin, and description of some of his experiments. 3000 w. Yale Sci M—Jan., 1898. No. 18312 C.

Furnace.

Contribution to the Study of the Electric Furnace. (Contribution à l'Étude des Fours Électriques.) A Memoir by MM Gin and Leleux to the French Academy, discussing the relations between temperature and current, as well as notes upon the behavior of materials fused in the electric furnace. 1800 w. *Comptes Rendus*—Jan. 17, 1898. No. 18521 D.

Fuses.

The Enclosed Fuse. D. J. Cartwright. A statement of the main features of various protective devices as they appear to the writer after careful study. Describes a new enclosed safety fuse designed by the writer. 1800 w. *Am Elect'n*—Feb., 1898. No. 18239.

Galvanometer.

A Sensitive Mirror Galvanometer. James F. Hobart. Illustrated description of an instrument intended to obviate, almost entirely, the necessity for skilled manipulation, yet will give results closely approaching those received from a more costly instrument. 1300 w. *Am Elect'n*—Feb., 1898. No. 18241.

India-Rubber.

The India-rubber and Gutta-percha Industries as Applied to Electrical Engineering. J. Wright. An account of how India-rubber is obtained and its preparation for commercial uses, dealing only with such processes as are involved in its preparation for electrical purposes. Ill. 3600 w. *Ind & East Eng*—Jan., 1898. No. 18410 D.

Low Resistance.

A Method for the Accurate Measurement of Low Resistance. Wilbur M. Stine. The method described is a modification of the Cary-Foster method. The essential idea is the employment of the standard of low resistance as the bridge wire. 1300 w. *Elec Wld*—Feb. 26, 1898. No. 18627.

Magnetic Fields.

Apparatus for Measuring Magnetic Fields. (Apparat zur Messung Magnetischer Felder.) Dr. Bruger. A flat spiral of bismuth is used, the change of resistance becomes a measure of the magnetic strength. 800 w. *Elektrotech Zeitschr*—Jan. 20, 1898. No. 18580 B.

New Method of Measuring the Intensity of Magnetic Fields. (Nouvelle Méthode pour la Mesure de l'Intensité des Champs Magnétiques.) M. E. Bouty. A liquid conductor is used in connection with the Lippman capillary electrometer. 1200 w. *Comptes Rendus*—Jan. 17, 1898. No. 18522 D.

On the Magnetic Field Due to a Current in a Wire Placed Parallel to the Axis of a Cylinder of Iron. G. F. C. Searle. An account of investigations made considering first the case of a cylinder of infinite radius. 2800 w. *Elect'n, Lond*—Jan. 28, 1898. Serial. 1st part. No. 18295 A.

Magnetism.

The Magnetic Properties of Tempered Steel. (Propriétés Magnétiques des Aciers Trempés.) Mme. Skłodowska Curie. A very valuable pa-

per upon the influence of tempering and of composition upon the capacity of steel for permanent magnets. 25000 w. *Bulletin de la Société d'Encour*—Jan., 1898. No. 18532 G.

Magneto-Optics.

On the Theory of Magneto-Optic Phenomena. C. H. Wind. An examination of the theories advanced; the relation existing between the present theory and some of the older ones; and other features of the subject. 1900 w. *Phys Rev*—Jan., 1898. Serial. 1st part. No. 18-095 D.

Metallic Conductors.

On the Electrical Conductivity of Metallic Conductors. Edouard Branly. From the *Comptes Rendus*. An account of recent experiments. 900 w. *Elec Eng, N. Y.*—Feb. 17, 1898. No. 18445.

Report.

Report of the Work of the Physical-Technical Reichsanstalt. (Thätigkeits Bericht der Physikalisch-Technischen Reichsanstalt.) A general résumé of the work of the Imperial testing bureau, giving many details of work done, especially in examining and comparing standards. Two articles. 6000 w. *Elektrotech Zeitschr*—Feb. 3, 10, 1898. No. 18586 E.

Rheostats.

Liquid Rheostats. H. S. Webb. Tests made to obtain data from which the dimensions of a liquid rheostat for the dissipation as heat of a given amount of energy could be calculated, when the maximum current and E. M. F. are known. 1200 w. *Am Elect'n*—Feb., 1898. No. 18-237.

Sparking.

Sparking in Dynamos. Eustace Thomas. Briefly explains the causes of sparking, and shows the inadequacy of the commonly-accepted theories. Discusses the mathematical equations, and the practical conditions which give a minimum of sparking. The advantages of multipolar construction are especially emphasized. 2000 w. *Elect'n, Lond*—Feb. 18, 1898. No. 18737 A.

Storage Battery.

See Street and Electric Tramways.

Transformers.

Practical Methods of Transformer Testing. J. H. Barbour and K. G. Glover. Abstract of a thesis test. Gives methods used. Ill. 900 w. *Sib Jour of Engng*—Feb., 1898. No. 18611 C.

Wire.

Concerning Weatherproof Wire. Alex. Dow. Defending the use of this covering and showing that it has a value. 2000 w. *Elec Engng*—Feb. 1, 1898. No. 18092.

X-Rays.

The Source of the X-Rays. John Trowbridge and John E. Burbank. Describes experiments made with various tubes and states results. Ill. 2000 w. *Am Jour of Sci*—Feb., 1898. No. 18129 D.

MARINE ENGINEERING.

American Shipping.

Arthur Sewall's Views on American Shipping. An article from the *N. Y. Tribune*, giving an interesting interview. 3700 w. Sea—Feb. 17, 1898. No. 18453.

Cruiser.

H. M. S. Argonaut. Description, with illustration, of a protected cruiser of the Diadem type, launched Jan. 24, 1898, from the yard of the Fairfield Shipbuilding Co. 2000 w. Engr, Lond—Feb. 4, 1898. No. 18377 A.

Dock.

The Floating Dock for the Harbor of Loanda. (Schwimmdock für den Hafen von Loanda.) With photograph of the dock afloat as well as longitudinal and cross sections. 1000 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1898. No. 18548 D.

Dry Docks.

See Civil Engineering, Harbors.

Ferry Boats.

Danish Ferry Boats. (Die in Dänemark in Verwendung stehenden Ueberfuhrsboote.) An account of the ferry systems in use among the islands of Denmark, both for general traffic and for transportation of railway cars. 1 plate. 2500 w. Oesterr Monatschr f d Oeffent Bau-dienst—Feb., 1898. No. 18560 D.

Framing.

Some Considerations in Connection with the Transverse Framing of Ships. H. E. J. Camps. Read before the N. E. Coast Inst. of Engs. and Shipbuilders, at West Hartlepool. The type of vessel chosen for discussion is a three-deck ship, and the writer considers what she would have been if built on each of the several systems of framing. Ill. 2300 w. Ind & Ir—Jan. 21, 1898. Serial. 1st part. No. 18145 A.

H. M. S. "Diadem."

Trials of H. M. S. "Diadem." Editorial on the trials now taking place in the English Channel, giving some of the features of the ship and her machinery. 1800 w. Engng—Jan. 21, 1898. No. 18135 A.

Iron Ships.

The Earliest Iron-Built Ships. Historical review of the earliest efforts at iron-ship construction in Great Britain. 2200 w. Engr, Lond—Jan. 21, 1898. No. 18116 A.

Japan.

See Economics and Industry, Commerce.

Paddle Steamer.

Hungarian Paddle Steamer I. Ferencz Jozef. Working drawings and description of the engines of this steamer, which has been previously indexed. 700 w. Eng, Lond—Feb. 4, 1898. No. 18374 A.

Propellers.

Defects in Propeller Shafts. M. W. Aisbitt. Abstract of paper read at meeting of Inst. of Marine Engineers, Cardiff. Presents certain

defects and discusses means of remedying them. Also discussion. 6000 w. Steamship—Feb., 1898. No. 18338 A.

Revenue-Cutter Service.

The United States Revenue-Cutter Service. H. D. Smith. Historical account of the service, its hardship and danger, giving interesting incidents. Ill. 4800 w. Century Mag—Feb., 1898. No. 18125 D.

Russian Yacht.

The Russian Imperial Yacht "Standart." Elevations and plans of the ship, with interior views and description. 2500 w. Engng—Jan. 28, 1898. No. 18269 A.

Shipbuilding.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. In this paper Mr. McKechnie discusses the economic features of the situation, and shows that in the rising competition the ratio of output to wages is the deciding factor. 3500 w. Engineering Magazine—March, 1898. No. 18593 B.

Ship Yard.

Most Modern of Lake Ship-Yards. Illustrates and describes some of the details of the plant at Lorain, Ohio. 1100 w. Ir Trd Rev—Feb. 24, 1898. No. 18680.

Signal Apparatus.

Rotary Field Signal Command Apparatus. (Drehfeld-Fernzeiger als Signal- und Kommando Apparat.) Describing an improved form of dial signal apparatus for communication of orders from the bridge to the engine room of a vessel. The indications are transmitted by the rotation of a magnetic field. 4500 w. Glaser's Annalen—Feb. 1, 1898. No. 18567 D.

Steam Yacht.

Description of the New Steam Yacht for Colonel Oliver H. Payne. General design, dimensions and description of a fine yacht to be built by the Bath Iron Works, of Bath, Me. 2200 w. Marine Engng—Feb., 1898. No. 18298 C.

Submarine Boat.

Construction and Operation of the Submarine Boat Argonaut. Photographs and scale drawing with description of construction and operation. 2200 w. Marine Engng—Feb., 1898. No. 18297 C.

Travelling Gantry.

See Mechanical Engineering, Shop & Foundry.

Water Ballast.

Water Ballast in Steamers. Side Tanks. Archibald M'Glashan. Read at meeting of North-East Coast Institution of Engineers and Shipbuilders, at West Hartlepool. An inquiry into the question of how far recent developments in shipbuilding and in the working of steamers affect this subject. Discussion. 2500 w. Steamship—Feb., 1898. No. 18339 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Tests.

Tests of Water-Tube Boilers With Horizontal and Vertical Passes. George H. Barrus. Describes tests made on two 200 h. p. horizontal water-tube boilers set side by side in one battery of brick work. 900 w. Eng Rec—Feb. 19, 1898. No. 18637.

Circulation.

The Circulation of Water in Steam Boilers. (La Circulation de l'Eau dans les Chaudières.) Ch. Bellens. Discussing and in some respects opposing the recent theories of M. Brillié upon the same subject. Serial. 1st part. 3500 w. La Revue Technique—Jan. 25, 1898. No. 18527 D.

Draft.

Improved System of Mechanical Draft for Furnaces. (Nouveau Procédé de Tirage Mécanique des Foyers.) The Prat system uses a blast of air from a fan blower to induce a current in a larger vertical aspirator connected to the boiler flue. Excellent results are obtained at small cost. 3000 w. Le Génie Civil—Jan. 29, 1898. No. 18511 D.

Furnaces.

Increasing the Draught of Furnaces. From *Uhlands Technische Rundschau*. Reviews the methods for increasing the draught of a chimney shaft, and briefly discusses which is preferable. 1500 w. Col Guard—Feb. 4, 1898. No. 18382 A.

Heaters.

Feed-Water Heaters and Economizers. William H. Fowler. Deals with feed water heaters and fuel economizers. Ill. 2800 w. Ry Wld—Feb., 1898. No. 18393 A.

Incrustation.

Removal of Boiler Incrustations. (Désincrustation des Chaudières.) M. Schmidt. Describing the success obtained in loosening boiler scale by rapid cooling and washing out when cold. 6000 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18534 G.

Superheating.

The Application of Superheated Steam. (Die Anwendung Ueberhitzten Dampfes.) M. F. Gutermuth. A theoretical discussion, accompanied by extensive tables of tests as well as illustrations of the Schmidt boiler and superheater. 6000 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1898. No. 18551 D.

The Schoerer Steam Superheater. (Der Dampfüberhitzer von Schwörer.) A general discussion of superheating with data of tests showing an economy of about 20 per cent. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1898. No. 18550 D.

Tests.

Boiler Testing with Various Fuels. David P. Jones. Abstract of paper read before the Am.

Soc. of Naval Engs., at Washington, D. C. Discusses methods of testing with coal, oil, waste gases of blast furnaces, and bagasse. 3800 w. Eng News—Feb. 3, 1898. No. 18203.

Volatile Oils.

Physical and Chemical Properties of Volatile Oils in Boilers. W. H. Edgar. Address before the Northwestern Elec. Assn. at Milwaukee. Discusses the use of oils to counteract the evil effect of incrustation, especially of kerosene and petroleum and their different distillates. Discussion. 4400 w. W Electn—Jan. 29, 1898. No. 18151.

COMPRESSED AIR.

Compressors.

New Types of Ingersoll-Sergeant Air Compressors. Describes two recent designs. Ill. 800 w. R R Gaz—Feb. 11, 1898. No. 18328.

Explosions.

Compressed-Air Explosions—A Recent Typical Explosion. Frank Richards. Considers the dangers from imperfect design and mismanagement. 1500 w. Am Mach—Feb. 3, 1898. No. 18248.

Explosions in Air Compressors and Receivers. T. G. Lees. Abstract of paper read at meeting in Sheffield, Eng. Describes explosions which occurred at Clifton Colliery, the conditions which caused them and gives lessons to be learned. 2400 w. Ir & Coal Trds Rev—Feb. 11, 1898. No. 18605 A.

Formulas.

Useful Compressed-Air Formulas. W. L. Saunders. Gives rules and formulas used by the writer in the application of compressed air. 1000 w. Compressed Air—Feb., 1898. No. 18638.

ENGINES AND MOTORS.

Accumulators.

The Manufacture of Tudor Accumulators. Illustrated detailed description. 1800 w. Elec Rev, Lond—Jan. 28, 1898. No. 18291 A.

Diesel Motor.

Recent Developments in Diesel Motors. Information from report of Alfred Musil published in the *Journal für Gasbeleuchtung*, with short biographical sketch and portrait of Rudolph Diesel. 1300 w. Pro Age—Feb. 15, 1898. No. 18412.

The Diesel Oil-Motor. Interesting particulars from articles by Bryan Donkin and M. Hospitalier. Ill. 3000 w. Automotor Jour—Feb., 1898. No. 18677 A.

The Diesel Rational Heat Motor. States the conditions regarded as essential for an economic heat engine, defines ignition and combustion, and gives comparison of efficiency, &c. Ill. 2800 w. Elec Eng, N. Y.—Feb. 17, 1898. No. 18447.

Engine Development.

Long-Stroke Cylinders and Piston Valves

George W. Cushing. Facts showing advances made and what has influenced the progress. Ill. 2500 w. Ry Mas Mech—Feb., 1898. No. 18257.

Exhaust.

The Economical Utilisation of Exhaust Steam. Bryan Donkin. Reviews the various methods of utilising the energy in exhaust steam, comparing the relative economy of jet and surface condensation as well as the use of exhaust for feed water heating. 2500 w. Engineering Magazine—March, 1898. No. 18592 B.

Generating Unit.

See Electrical Engineering, Lighting.

Horizontal Engine.

Horizontal Engine at the Brussels Exhibition. Illustrated description of engine constructed by the firm of M. J. Preudhomme-Prion, of Huy, Belgium, which was received with favor. 600 w. Engng—Feb. 11, 1898. No. 18479 A.

Injectors.

Locomotive Injectors. J. A. Bischoff. Read at the Locomotive Foreman's Club, Chicago. Treats of the essential active parts of an injector, the action, and causes which prevent working, with suggestions. 3000 w. Ry Mas Mech—Feb., 1898. No. 18258.

Intercepting Valves.

Some Engineering Designs, as Shown in Intercepting Valves for Locomotives. Illustrates and describes several designs 1200 w. Am Mach—Feb. 24, 1898. No. 18686.

Pumping Engine.

Pumping Engines. R. J. Worth. Read at Cleveland Inst. of Engineers, at Stockton-on-Tees. Abstract giving points on engines in general, and briefly considering special types. Short discussion. 2000 w. Col Guard—Jan. 21, 1898. No. 18141 A.

See Municipal Engineering, Sewerage.

See Municipal Engineering, Water Supply.

Slide Valves.

Setting Slide Valves. Thomas Hawley. Abstract of a lecture delivered before the Wells Memorial Inst., Boston. Gives some points and suggestions regarding the methods. 1800 w. Bos Jour of Com—Feb. 12, 1898. No. 18353.

Steam Gages.

Some Notes on Locomotive Steam Gages. Theo. H. Curtis. How steam gages may be in error even when shown to be correct by the test-gage. 1000 w. Ry Mas Mech—Feb., 1898. No. 18259.

Steam Plant.

Test of Steam Plant of the Hood Rubber Co., East-Watertown, Mass. George H. Barrus. Illustrates complete test of engines and boilers. 3000 w. Eng Rec—Feb. 5, 1895. No. 18218.

POWER AND TRANSMISSION.

Canada.

Water Power in Canada. Presidential address at the annual meeting of the Canadian So-

ciety of Civil Engineers. Calls attention to this widely distributed power, its use for transmission purposes, electrical demand, the ice question, &c. 4500 w. Can Engr—Feb., 1898. No. 18323.

Compression.

The Compression of Steam in the Clearance Space. (Sur la Compression de la Vapeur dans l'Espace Mort.) H. Hubert. A discussion of Prof. Déry's investigations into the losses due to condensation during compression. 3500 w. Revue Universelle des Mines—Jan., 1898. No. 18536 H.

Elevators.

Elevators and Their Inspection. H. V. Loss. Read before the International Convention of Building Commissioners and Inspectors at Detroit. A criticism of the methods employed by the elevator casualty insurance companies, and suggestions considered important for the safety of elevators. 2500 w. Arch & Build—Feb. 19, 1898. Serial. 1st part. No. 18618.

Hydraulic or Electric Elevators. Two communications from P. R. Moses and Horatio A. Foster on the relative economy of hydraulic and electric apparatus. 2000 w. Eng Rec—Feb. 5, 1898. No. 18216.

Modern Elevators. Fred C. Floyd. Read before the International Convention of Building Commissioners and Inspectors, at Detroit. Considers the causes that have made the elevator a necessity, and the efficiency that has made possible the erection of high buildings; also the dangers, and safety devices. 3200 w. Arch & Build—Jan. 29, 1898. No. 18096.

Exposition.

Steam Engines at the Brussels Exposition, 1897. (Exposition de Bruxelles 1897. Les Moteurs à Vapeur.) Emile Masson. A general account of the steam engines exhibited, including among others, the Schmidt Superheated steam engine. 6000 w. 1 plate. Revue Universelle des Mines—Jan., 1898. No. 18537 H.

Power Presses.

Early Power Presses. Work of a Vermont man in this line with some information from N. C. Stiles. Ill. 800 w. Mach, N. Y.—Feb., 1898. No. 18301.

Power Sources.

Steam, Gas and Electricity as Sources of Energy in Chemical Works. F. H. Bowman. Read before the Manchester Section of the Society of Chemical Industry, England. Discusses the advantages and disadvantages of each of the sources named. 2200 w. Jour Gas Lgt—Jan 25, 1898. No. 17705 A.

Water-Wheel Regulation.

Regulation of Water-Wheels under High Pressure. Describes method of regulation of Pioneer Electric Power Co.'s wheels. 800 w. Eng Rec—Feb. 5, 1898. No. 18215.

Speed Government in Water-Power Plants. Mark A. Replogle. Discussion of some of the principles that must be adhered to if successful regulation is to be obtained. Ill. 6400 w. Jour Fr Inst—Feb., 1898. No. 18263 D.

Water-Wheels.

Horse Power of Water-Wheels and Turbines. Olin H. Landreth. Gives a diagram for the graphical determination of the horse power of any given water fall, explaining how to use it. 400 w. *Am Elect'n*—Feb., 1898. No. 18240.

Wave Power Generator.

See Electrical Engineering, Power.

Worm Gearing.

See Street and Electric Tramways.

SHOP AND FOUNDRY.**Blower.**

The Uses of the Blower in the Foundry. Walter B. Snow. Read before the New England Foundry Men's Assn. Gives the theoretical considerations which govern the design of fan blowers and their operation, the different types employed in the foundry and some of the uses. 4000 w. *Ir Age*—Feb. 10, 1898. No. 18317.

Brass.

The Influence of Antimony on the Cold Shortness of Brass. Erwin S. Sperry. An account of experiments made by varying the amount of antimony of a constant composition. Ill. 4500 w. *Trans Am Inst of Min Eng's*—Feb., 1898. No. 18470 D.

Brass Furnaces.

Improved Brass Furnaces. D. C. Thompson. Gives a description, with illustrations, of twin furnaces of the cylinder type. 1500 w. *Foundry*—Feb., 1898. No. 18260.

Centrifugal Force.

Diagram for Finding Centrifugal Force and Rim Tension. N. J. Hopkins. Explanation for the use of curves which will reduce the labor of calculating. 250 w. *Am Mach*—Feb. 17, 1898. No. 18437.

Coupling.

The de Bovet Magnetic Coupling. (*Magnetische Kupplungen, System de Bovet.*) The device consists of a cone coupling drawn into engagement by a powerful annular electro-magnet. Various modified arrangements are shown. 1200 w. *Zeitschr d Oesterr Ing u Arch Ver*—Feb 11, 1898. No. 18545 B.

Cupolas.

Cupola Linings. Linson H. De Voe. Read at meeting of the Foundrymen's Assn., Philadelphia. Briefly outlines several methods. 2200 w. *Ir Age*—Feb. 10, 1898. No. 18314.

Die.

Die for Punching Holes in Armature Blanks. William Baxter, Jr. Illustrated description. 1200 w. *Am Mach*—Feb. 10, 1898. No. 18332.

Drawings.

Black-Print Processes. Albert E. Guy. Mentions the defects of the blue-print process, and presents the difficulties attending the manufacture of black-print paper. 2500 w. *Am Mach*—Feb. 17, 1898. Serial. 1st part. No. 18432.

Drill.

The Davis Calyx Drill. An illustrated de-

scription of a drill, the special features being the cutter, which is of hardened steel; and the calyx, an apparatus for catching the particles of rock. 1600 w. *Ir & Coal Trds Rev*—Jan. 28, 1898. No. 18278 A.

Drying.

Modern Drying Apparatus. (*Moderne Trockenanlagen.*) A discussion of the action of heat in increasing the absorbing capacity of air for moisture, together with the theory of air-drying apparatus. 3000 w. *Zeitschr d Ver Deutscher Ing*—Jan. 22, 1898. No. 18549 D.

European Foundries.

Some Observations of an American Iron Man Abroad. Archer Brown. General account of points noticed which differ from American ways. 1300 w. *Foundry*—Feb., 1898. No. 18261.

Exhibition.

The Exhibition of Foundry Supplies at Goslar. (*Giesserei-Fachausstellung in Goslar.*) Describes many improved forms of molding machines, blowers and other foundry apparatus, as exhibited at Goslar, Hanover, in September, 1897. Three articles, 10000 w. 1 plate. *Stahl und Eisen*—Jan. 15, Feb. 1, 15, 1898. No. 18568 H.

Flat Heads.

Investigation of Distortion and Resistance of Flat Heads. C. Bach. Translated and abridged by Gus C. Henning, from the *Zeitschrift des Vereines Deutscher Ingenieure*. Investigations in this field, covering flanged heads of wrought and cast materials, giving tests. Ill. 1500 w. *Am Mach*—Feb. 17, 1898. No. 18436.

Gun Factory.

The Gun Factory at the United States, Washington, D. C., Navy Yard. Illustrated description of the work as carried on at this shop. 1500 w. *Sci Am*—Feb. 26, 1898. No. 18644.

Hammers.

Steam Hammers—Past and Present. Illustrated description of old forms and new, showing the great progress made in this century. 2000 w. *Ir & Coal Trds Rev*—Feb. 11, 1898. No. 18604 A.

Iron Alloys.

Chemistry in Foundry Practice. S. S. Knight. An introduction to a series of articles relating to this subject. Part first deals with two alloys of iron, giving experiments of the writer. 2200 w. *Foundry*—Jan., 1898. No. 18187.

Jacquard Machine.

The Verdol Jacquard Machine. (*Piquage Mécanique Verdol.*) A report upon the improved apparatus of M. Verdol in which perforated paper is substituted for the original form of Jacquard cards. The machine for piercing the cards is fully described and illustrated. 7500 w. *Bulletin de la Société d'Encour*—Jan., 1898. No. 18530 G.

Lathes.

An 8"x20" Bench Lathe for the Amateur Electrician. Herbert I. Washburn. Illustrated description of a proposed design. 600 w. *Am Mach*—Feb. 10, 1898. No. 18331.

Lock Nuts.

The Helicoid Lock Nut. Illustrated description of a locking nut possessing the virtues of locking, and that it can be screwed on and off its bolt with facility. The manufacturing works are illustrated and the operations given in detail. 2200 w. Engng—Feb. 4, 1898. No. 18370 A.

Lubricator.

A Continuous Automatic Lubricator. (Grais-seur Automoteur Continue.) A Report upon the improved lubricator designed by M. Barré. A continuous circulation of oil is maintained by an automatic pumping device. 3500 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18531 G.

Melting.

Economy in Melting. J. P. Pero. Considers in detail the factors involved in melting iron economically. 2400 w. Foundry—Jan., 1898. No. 18188.

The Melting Ratio. W. F. Prince. Discusses the progress and improvements in the melting and cupola practice. 1500 w. Foundry—Jan., 1898. No. 18189.

Metal Stamping.

Development of Machinery for Sheet Metal Stamping. Oberlin Smith. A review of the increasing use of stamped metal work for many purposes in which more expensive methods were formerly used; with many examples of products of the stamping and drawing press. 3500 w. Engineering Magazine—March, 1898. No. 18596 B.

Mixtures.

Changes in Foundry Mixtures. Eugene W. Smith. Read before the Western Foundrymen's Assn. Presents some of the mechanical changes due to handling, showing the absolute care that must be taken to obtain uniform results. 1200 w. Ir Age—Feb. 24, 1898. No. 18639.

Molding.

The Avery Molding Machine. Illustrated description of an apparatus and plan of molding in strange contrast to the usual custom, but which has more than satisfied the expectations. 1500 w. Foundry—Jan., 1898. No. 18184.

The Molder's Hot Spot. R. D. Moore. Examples given illustrate points requiring skill and give suggestions. Ill. 1000 w. Foundry—Jan., 1898. No. 18186.

Nickel Steel.

Nickel Steel for Crank Pins and Axles. H. F. J. Porter. A paper containing much information concerning steel, with results of tests, mechanical treatment, improvement of quality, &c. 3300 w. R R Gaz—Feb. 25, 1898. No. 18664.

Oxidation.

Oxidation of Foundry Metals. Thomas D. West. Read before the Pittsburg Foundrymen's Assn., Jan. 31, 1898. Reports a series of original tests, and concludes that if it were possible to secure clean iron, free of all sand, rust or film of oxid, the loss of metallic iron due

to oxidation would not be as large as has been generally supposed. 2500 w. Ir Trd Rev—Feb. 3, 1898. No. 18185.

Phosphorus.

Effects of Phosphorus on the Strength and Fusibility of Iron. Thomas D. West. Read at meeting of the Pittsburg Foundrymen's Assn. Gives experiments and results. 900 w. Am Mfr & Ir Wld—Feb. 4, 1898. No. 18250.

Planing.

Time Saving in Planing. Henry Hess. Gives methods and shows the importance of the highest possible cut-rate and the small value of further increase of speed on the return stroke. 1000 w. Am Mach—Feb. 24, 1898. No. 18685.

Riveting.

Experiments on the Resistance of Riveted Plates to Slipping. (Expériences sur la Résistance des Tôles Rivées au Glissement.) A full account of the experiments made in Holland by Schroeder van der Kolk with details of the apparatus and diagrams from the autographic records of the testing machine. Three articles. 7500 w. Le Génie Civil—Dec. 25, 1897, Jan. 1, 8, 1898. No. 18502 H.

Roller Bearings.

Modern American Roller Bearings and their Reduction of Friction. (Ueber die Neuen Ameri-Kanischen Rollenlager und die damit Erzielte Ersparniss an Reibung.) Prof. F. Reuleaux. Paper before the German Railway Society, with many illustrations of ball and roller bearings and their mechanical applications. 7500 w. Glaser's Annalen—Feb. 1, 1898. No. 18566 D.

Screw Cutting.

Accurate Screw Machine Work—Screw Cutting. J. O. Surface. Explanation of some methods and tools by which difficulties in this work may be overcome. Ill. 1500 w. Am Mach—Feb. 3, 1898. No. 18249.

Screw Threads.

Instruments for Gauging Screw Threads. (Sur les Instruments Vérificateurs des Filetages.) M. Marré. Describing a system of gauges intended for use on the metric screw thread system known as the *Système Français*, (S. F.) with table for the system. 6000 w. Bulletin de la Société d'Encour—Jan., 1898. No. 18533 G.

Test Bars.

Test Bars and Their Relation to the Strength of Castings. Herbert E. Field. Considers that the test bars fail to accomplish the purpose for which they are used. 2800 w. Mach, N. Y.—Feb., 1898. No. 18300.

Tools.

Tool Books. L. D. Burlingame. Suggestions for keeping a systematic record of all tools for special work. 1800 w. Am Mach—Feb. 17, 1898. No. 18433.

Travelling Gantry.

Travelling Gantry at Messrs. Harland and Wolff's Shipyard, Belfast. Describes machines used for lifting of plates and sections into po-

sition, and to support riveting machines when at work. 1100 w. Engng—Jan. 28, 1898. No. 18266 A.

Wire Mill.

A Copper Wire Mill. R. An interesting account of a visit to the Wacark Manufacturing Company at Bay View, N. J., describing the operations. 1900 w. Am Mach—Feb. 17, 1898. No. 18434.

MISCELLANY.

Aeronautics.

Aeronautics in 1897. (Die Aëronautik im Jahre 1897.) A general review of progress in the past year, with especial reference to the mechanical features involved. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 11, 1898. No. 18544 B.

Agricultural Machinery.

Agricultural Machinery and Tools Exhibited at Stuttgart and Hamburg. (Die Landwirthschaftlichen Maschinen und Geräte in Stuttgart und in Hamburg.) Giving illustrations of many of the modern plows, cultivators and similar machines shown at these recent exhibitions. Serial. 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1898. No. 18546 D.

Analytical Work.

The Dignity of Analytical Work. C. B. Dudley. Presidential address delivered at the Washington meeting of the American Chemical Society. A discussion of analytical work, its value and importance, giving illustrations and examining the differences in the work of pure and applied chemists. 6300 w. Science—Feb. 11, 1898. No. 18335.

Automobiles.

Motor Wagons for Municipal Work. F. J. Warden-Stevens. A discussion of the suitability of these vehicles for this work, the kind of power to be adopted, &c. 2000 w. Arch, Lond—Feb. 11, 1898. No. 18498 A.

Some Difficulties of Motor-Vehicle Construction. Deals with the difficulties to be found in the application of oil to the moving of road-vehicles. 2000 w. Automotor Jour—Feb., 1898. No. 18678 A.

Some Points in the Design of Automobile Vehicles Intended for Heavy Traffic. George Herbert Little. Abstract of a paper read before the Self-Propelled Traffic Assn., of Liverpool. Part first considers the means of effecting cheap internal transport by means of automobile vehicles, existing practice in handling heavy loads, the features of the most recent examples of automobile vehicles, &c. 4400 w. Ind & Ir—Jan. 28, 1898. Serial. 1st part. No. 18281 A.

Bicycles.

Chainless Bicycles. Howard Lee Davis. Describes the difficulties overcome, the construction, and tests made. Ill. 2000 w. Yale Sci M—Jan., 1898. No. 18313 C.

Breech Mechanism.

Schneider-Canet Quick-Firing Breech Mechanism. Illustrated description of the 15 cm. (5.9 in.) breech gear. 1200 w. Engr, Lond—Feb. 11, 1898. No. 18482 A.

Deformation.

The Law of the Deformation of the Industrial Metals. (Loi des Déformations des Metaux Industriels.) Marcel Brillouin. A mathematical discussion of deformations, based on the crystalline structure of the material, and including the time element, and the influence of shocks. 1200 w. Comptes Rendus—Jan. 24, 1898. No. 18523 D.

Elasticity.

Report on the Investigations of MM. Gossot and Lionville. (Rapport sur les Travaux de MM. Gossot et Lionville.) An abstract of investigations into the elastic action of steel hoops when used as reinforcements for tubes, as in the case of artillery. Prize paper of the French Academy. 2000 w. Comptes Rendus—Jan. 10, 1898. No. 18517 D.

Frictional Losses.

Frictional Losses in a Hydraulic Intensifier. Walter Ferris. Gives experiments made at the Pencoyd Iron Works, with the idea of obtaining information as to the frictional losses in hydraulic machinery and to see to what extent the formulas given by engineering authorities correspond with practice. 1400 w. Am Mach—Feb. 3, 1898. No. 18247.

Hydraulic Jointing.

Hydraulic Jointing of Tubular Structures. Illustrated description of process invented by Charles T. Crowden. 2500 w. Ind & Ir—Feb. 4, 1898. No. 18387 A.

Maxim Gun.

The Maxim Gun. It is proposed to give a somewhat full description of the gun as it now exists. Part first considers the origin of the gun and some of the steps by which it has been brought to its present development. Ill. 2500 w. Engng—Feb. 11, 1898. Serial. 1st part. No. 18477 A.

Refrigerating Machines.

Medium and Small Independent Refrigerating Plants. Illustrated description of the methods of refrigerating adopted by the Atlantic Refrigerating Co., of Springfield, Mass. 1200 w. Sci Am—Feb. 12, 1898. No. 18308.

Rubber.

Singular Stress-Strain Relations of India-Rubber. R. H. Thurston. From *Science*. Calling attention to the rapid increase in resistance just before rupture. 900 w. Sib Jour of Engng—Feb., 1898. No. 18612 C.

Submerged Pipe.

A Submerged Steel Pipe with Flexible Joints at Portland, Ore. Points of interest in this work and part of the specifications relating to the flexible and flanged joints. Ill. 1400 w. Eng News—Feb. 10, 1898. No. 18322.

Testing.

On the Permanent Deformation and Rupture of Metals. (Sur les Déformations Permanentes et la Rupture des Metaux.) M. G. A. Faurie. An examination of the phenomena of nodality in metals under tension tests. 1000 w. Comptes Rendus—Jan. 31, 1898. No. 18524 D.

MINING AND METALLURGY.

COAL AND COKE.

Bituminous Collieries.

Surface Plants of Bituminous Collieries. W. G. Wilkins. Read at meeting of Ohio Inst. of Min. Eng. Calls attention to some of the principles and appliances that should be considered in the design, laying out, and construction of the surface plants of bituminous collieries, in order to save labor and expense, and therefore reduce the surface cost of the mine output. 4400 w. *Am Mfr & Ir Wld*—Jan. 28, 1898. No. 18103.

Coal Deposits.

Structure of the Coal Deposits of the Trans-Mississippian Field. Charles R. Keyes. Calls attention to features brought out by recent information of this region, and facts that have an important bearing upon mining. 2500 w. *Eng & Min Jour*—Feb. 26, 1898. Serial. 1st part. No. 18684.

Coal Dust.

Precautions Against the Dangers of Coal Dust. From M. Haton de la Goupillière's *Course of Mine Working*. Gives methods in use as a preventive against danger. 2000 w. *Col Guard*—Feb. 11, 1898. No. 18603 A.

Coal Measures.

Clay Veins Vertically Intersecting Coal Measures. W. S. Gresley. Presents a record of observations on dike-like deposits of clay and other material traversing the bituminous-coal regions west of the Allegheny Mountains, together with illustrations of and references to allied phenomena in other countries. 6800 w. *Bul of Geol Soc of Am*—Jan. 18, 1898. No. 18407 D.

Coal Mining.

Tests of an Electric Coal-Mining Plant. Clifford Buck and Clay Belsley. Report presented as a thesis at Sibley College, Cornell Univ. An unusually fine piece of work of its class, showing the records of performance and efficiencies of electric-driven apparatus under conditions of actual work in a coal mine. 2400 w. *Eng News*—Feb. 24, 1898. No. 18652.

Coke.

The Sulphur Contents of Coke in their Relation to Blast Furnace and Cupola Practice. Oscar Simmersbach. Translated from *Stahl und Eisen*. States on what the sulphur contents in coke depends, why sulphur in coke is injurious in the blast furnace, and in the cupola, and suggests how lower sulphur contents may possibly be obtained. 1800 w. *Am Mfr & Ir Wld*—Jan. 28, 1898. No. 18101.

Culm Flushing.

The Method and Cost of Flushing Culm into Anthracite Mines. Report of the committee appointed to investigate this subject, prepared by James B. Davies, superintendent of the "Black Diamond" and "Dodsie" collieries. Gives the mode of filling these mines with culm,

the expenses and suggestions for improvements. Ill. 7000 w. *Anth Coal Op Assn*—Feb., 1898. No. 18207.

Explosion.

The Sunshine Coal Mine Explosion. An extract from a special report made to the governor of Colorado by the inspector of mines, David Griffiths. Ill. 2000 w. *Mines & Min*—Feb., 1898. No. 18347 C.

Formation.

The Rock Formation at La Tombe. (Le Massif de La Tombe.) A paper by M. J. Smeysters, upon the formations and faults in the coal measures about Charleroi, Belgium. 5000 w. 4 plates. *Revue Universelle des Mines*—Jan., 1898. No. 18535 H.

France.

Saint-Eloy Collieries, Allier, France. From notes of a visit by members of the Société de l'Industrie Minérale attending the Montluçon Congress, communicated to the *Comptes Rendus Mensuels* of the society. Describes deposit, method of working, shafts, boilers, haulage, &c. 1500 w. *Col Guard*—Feb. 11, 1898. No. 18600 A.

Lancashire Coalfields.

The Nomenclature of the Lancashire Coalfields. Herbert Bolton. Abstract of paper read at special meeting of the Manchester Geological Society. Considers the terms that might have been or are still in use in referring to the seams of the lower measures. 1800 w. *Col Guard*—Feb. 4, 1898. No. 18383 A.

Nitrogen.

History of Nitrogen in Coal. Herman Poole. The object of the article is to recount some of the sources of the nitrogen in coal and to trace its history through its various changes. 2000 w. *Am Gas Lgt Jour*—Feb. 7, 1898. No. 18245.

Origin.

The Carboniferous Age and the Origin of Coal. A statement of the different theories advanced. Ill. 1500 w. *Ir & Coal Trds Rev*—Feb. 4, 1898. No. 18386 A.

The Origin of Coal. A. de Lapparent, in the *Revue de Questions Scientifiques*. From a lecture to the Société Scientifique, Brussels. Part first explains proper methods of investigation, and gives some theories of prominent geologists. 3000 w. *Col Guard*—Jan. 28, 1898. Serial. 1st part. No. 18270 A.

Safety Cage.

Moustier Safety Cage. M. Vallat. From a communication to the Société de l'Industrie Minérale, Saint-Etienne. Brief illustrated description. 700 w. *Col Guard*—Jan. 28, 1898. No. 18272 A.

Treatment.

The Mechanical Treatment of Coal. Horace J. Greaves. Read before the Derbyshire Metallurgical and Engineering Assn. The different methods are discussed, and the means of treating the various kinds of coal and their

value. 3800 w. Col Guard—Feb. 4, 1898. No. 18384 A.

COPPER.

Copper Deposits.

The Origin and Mode of Occurrence of the Lake Superior Copper-Deposits. M. E. Wadsworth. A description of the geology of this region, with discussion of the ore deposits, their origin, &c. 12400 w. Trans Am Inst of Min Eng—Feb., 1898. No. 18474 D.

Copper Mattes.

A Study of the Elimination of Impurities from Copper Mattes in the Reverberatory and the Converter. Edward Keller. A comparison of the two methods, working on the same material on an extensive scale. 7200 w. Trans Am Inst of Min Eng—Feb., 1898. No. 18469 D.

Refining.

Purification of the Electrolyte in Copper Refining. A translation of the essential portions of a paper by Titus Ulke, which appeared in the *Zeitschrift für Electrochemie*, with critical comments. 1600 w. Elect'n, Lond—Feb. 11, 1898. No. 18497 A.

Smelting.

The Garretson Copper Smelting Furnace. Illustrated description, with letter from E. D. Peters, Jr., explaining the theories and methods involved in the construction and operation. 1700 w. Eng & Min Jour—Feb. 5, 1898. No. 18219.

Wire Mill.

See Mechanical Engineering, Shop & Foundry.

GOLD AND SILVER.

Amalgamation.

Temperature in Amalgamation. Editorial calling attention to the fact, ascertained by experiment, that the cooling of the water used in the stamp-mill batteries very considerably increases the yield of gold. A few quotations from writers as to the cause of this difference are given. 1400 w. Eng & Min Jour—Jan. 29, 1898. No. 18105.

Assaying.

The Assaying of Gold Bullion. C. Whitehead and T. Ulke. Gives the method used by the United States mints and assay offices in assaying "unparted bars." 1600 w. Eng & Min Jour—Feb. 12, 1898. No. 18367.

The Assaying of Silver Bullion. C. Whitehead and T. Ulke. An explanation of methods used. 3300 w. Eng & Min Jour—Feb. 26, 1898. No. 18683.

Bromine Process.

The Bromine Extraction Process. Particulars of the process, furnished by Horace F. Brown. 1800 w. N Z Mines Rec—Jan. 17, 1898. No. 18416 B.

Comstock Lode.

The Deep Levels of the Comstock Lode. Urging the pumping out and resuming the work at depth. 2000 w. Min & Sci Pr—Feb. 5, 1898. No. 18309.

Coolgardie.

The Coolgardie Gold Fields Water Supply. Explains the scheme for supplying this great gold centre with an abundance of good water. 2500 w. Engr, Lond—Jan. 21, 1898. Serial. 1st part. No. 18118 A.

Cyanid Process.

Contributions to the Chemistry of the Cyanid Process. William Skey. Discusses how the cyaniding of gold is effected, the actual chemical decompositions that occur in the process, &c. 5000 w. N Z Mines Rec—Jan. 17, 1898. Serial. 1st part. No. 18415 B.

The Stamp Milling of Gold Ores in its Relation to Cyaniding. E. H. Johnson. Points out some things in milling practice which militate against the successful treatment of tailings and slimes. 1300 w. Chem & Met Soc of S. Africa—Dec. 18, 1897. No. 18130 D.

Dry Separation.

The Dry Separation of Gold and Copper. Franklin R. Carpenter. Explains a separating process recently patented, giving notes of literature examined and experiments made. 1100 w. Eng & Min Jour—Feb. 12, 1898. No. 18368.

Gold Absorption.

Absorption of Gold by Wooden Leaching Vats. Francis L. Bosqui. Gives results of observations tending to show that losses through this cause have been over-estimated. 1000 w. Eng & Min Jour—Feb. 26, 1898. No. 18682.

Gold Formations.

Gold Formation in California. W. H. Storms. Considers the formation of the Sierra Nevada, the great fissure system, faults, veins, gravels, &c., and the needs of the present time in this mining region. 3500 w. Min & Sci Pr—Jan. 29, 1898. No. 18254.

Kalgoorlie.

Kalgoorlie, Western Australia, and its Surroundings. George J. Bancroft. Abstract of paper read at the Atlantic City meeting of the Am. Inst. of Min. Engs. Information of the ores and manner of deposit. 1500 w. Eng & Min Jour—Feb. 19, 1898. No. 18621.

Klondike.

Mining Conditions in the Klondike. Extracts from a letter published in the *N. Y. Times* of Jan. 23d. Discouraging the going to this new gold field, reporting disappointment and suffering of those there, and the unreliability of the claims for sale. 2500 w. Eng & Min Jour—Jan. 29, 1898. No. 18108.

The Yukon Gold Fields. Considers Vancouver as a base of supplies, the transportation enterprises, and the situation at Dawson City. 1600 w. Cons Repts—Feb. 4, 1898. No. 18197 D.

Korea.

United States Gold Mine Concession in Korea. Some information relating to the value of the concession granted to James R. Morse for a period of twenty-five years, and other mining interests. 800 w. Cons Repts—Jan. 29, 1898. No. 18091 D.

Mother Lode.

The Mother Lode of California. Ross E. Browne. Locates and describes the lode, the ores, quartz bodies, gold product, treatment of ores, giving cost of production, methods of opening the mines, &c. Ill. 5500 w. Min & Sci Pr—Jan. 29, 1898. No. 18251.

Nuggets.

The Crystalline Structure of Gold and Platinum Nuggets. A. Liversidge. Abstract of a paper read before the Royal Society of N. South Wales. Illustrated description of nuggets from Australia with account of investigations made, showing that gold nuggets have not been built up by successive coatings. 2000 w. Eng & Min Jour—Feb. 19, 1898. No. 18623.

The Origin of Nuggets. A. Liversidge. Illustrated description of nuggets from various sections, with account of investigations. 2000 w. Aust Min Stand—Dec. 30, 1897. Serial. 1st part. No. 18292 B.

Ore Treatment.

Ore Treatment in Boulder County, Colorado. C. C. Burger. Describes a 50-ton chlorination plant and its machinery, which has been in operation six months, its success and its adaptability to tellurium ores. 2400 w. Eng & Min Jour—Jan. 29, 1898. No. 18106.

Placer Mining.

Placer Mining by Machinery. William M. Johnston. Reviews some of the methods adopted which often have resulted in loss, and endeavors to point out lines which may be safely followed. 3000 w. Min & Sci Pr—Feb. 5, 1898. No. 18310.

Quartz Mining.

Beginning of Quartz Mining in California. Almarin B. Paul. Reviews the history from 1848 to the discovery of the Comstock. Ill. 2300 w. Min & Sci Pr—Jan. 29, 1898. No. 18253.

Siberia.

The Natural Resources and Gold Bearing Strata of Siberia (La Sibérie, ses Ressources Naturelles et ses Gisements Aurifères.) A review of the recent work by M. R. De Batz, with much interesting and valuable information concerning this important country. 1800 w. Le Génie Civil—Jan. 29, 1898. No. 18513 D.

Silver Mines.

Silver Cliff District, Arthur Lakes. A description of a unique geological occurrence, and of the Racine Bay, Silver Cliff, Geyser, John Jay, and other mines, and of peculiar outbursts of carbonic-acid gas. Ill. 2000 w. Mines & Min—Feb., 1898. No. 18348 C.

Smelting.

The Influence of Altitude on Smelting. Herbert Lang. An explanation of the increased fuel consumption found necessary in smelting at high altitudes. 800 w. Eng & Min Jour—Jan. 29, 1898. No. 18107.

Stamp Mills.

Origin of the California Stamp. C. P. Stanford. An account of the early mills used and

the first California stamp-mill, with the principal improvements. Ill. 3500 w. Min & Sci Pr—Jan. 29, 1898. No. 18252.

Ural.

The Kotchkar Gold Mines, Oural Mountains, Russia. H. B. C. Nitze and C. W. Purington. Abstract of paper read at Atlantic City meeting of the Am. Inst. of Min. Eng. Describes these mines of eastern Russia and the manner of working. 2200 w. Eng & Min Jour—Feb. 19, 1898. No. 18620.

West Kootenay.

Mining Machinery in the Slocan. Howard West. Read before the meeting of the Brit. Col. Assn. of Min. Eng. Gives information of this division of West Kootenay and the machinery now in use. The writer thinks the district is destined to become a marvellous producer of the precious metals. 4000 w. Can Min Rev—Jan., 1898. No. 18086 B.

Some West Kootenay Ore Bodies. J. C. Gwillin. Read at meeting of Brit. Col. Assn. of Min. Eng. Gives analysis of the country rocks, and observations on the ore bodies of this district. 3000 w. Can Min Rev—Jan., 1898. No. 18087 B.

Witwatersrand.

The Gold Mines of the Witwatersrand, South Africa. John Hays Hammond. Mr. Hammond's second paper deals with the methods of working as well as the probable value and approximate duration of the gold supply, together with an account of the mining laws of the region. 2500 w. Engineering Magazine—March, 1898. No. 18590 B.

IRON AND STEEL.**Armor.**

American and European Armor Compared. W. L. C. From a paper by Captain O'Neil filed with the Senate Committee on Naval Affairs, discussing the relative superiority of American armor plate over that manufactured by the leading European firms. 3500 w. Ir Age—Feb. 10, 1898. No. 18316.

Basic Steel

Basic Refined Steel on the Continent. C. E. Stromeyer. From a paper read before the Institution of Engineers and Shipbuilders in Scotland. Discusses the three basic processes, and explains how far the basic refining process differs from that of the Thomas open-hearth, and further operations on the refined steel. 5800 w. Col Guard—Jan. 28, 1898. No. 18271 A.

Bending Tests.

Bending Tests of Iron and Steel Rails. Alfred Chatterton. Describes experiments undertaken originally to ascertain the loads old rails could safely carry, but the experiments were extended and the conclusions reached that in iron rails there is a gradual deterioration rendering them unfit for service; and that the effect on steel rails is to decrease their ductility and diminish their power of resisting deformation. Ill. 1500 w. Ind Engng—Jan. 8, 1898. 2 parts. No. 18390 D each.

By-Products.

The Recovery of By-Products of the Blast Furnace. A. Humboldt Sexton. A review of the various methods employed for the recovery of pitch, oil, paraffin and sulphate of ammonia from the discharge gases of blast furnaces; with reference to the practical operation of plants in the west of Scotland. 3500 w. Engineering Magazine—March, 1898. No. 18597 B.

Cast Iron.

The Effect of Ferro-Sodium on Cast Iron. Walter J. May. An account of the writer's experience with these fluxes. 800 w. Prac Eng—Jan. 28, 1898. No. 18296 A.

Gas Producers.

An Automatic Feed-Device for Gas Producers. C. W. Bildt. An illustrated description of a feed-device constructed and patented by the writer which has given satisfaction. 2200 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18466 D.

Modern Types of Gas Producers. Part first is largely introductory, discussing the use of gas for industrial purposes, the processes for making gas which have recently come into use, and commences the consideration of the different types of producers. Descriptions of the Thwaite duplex producer and the Thwaite single vessel producer are given. 3200 w. Ir & Coal Trds Rev—Jan. 21, 1898. No. 18163 A.

Ingots.

The Defects of Steel Ingots. (Les Défauts des Lingots d'Acier.) A critical study of the defects caused by over or underheating, sudden cooling, and variations in composition, together with an account of the influence of pressure, and the best precautions to be observed to obtain satisfactory results. Two articles. 7000 w. Le Génie Civil—Jan. 15, 22, 1898. No. 18508. G.

Iron Trades.

English and American Methods in the Engineering and Iron Trades. From presidential address of Henry Webb before the Manchester, (Eng.), Assn. of Engs., contrasting the methods, and suggesting various directions where American methods might be introduced with economy. 2200 w. Engr, Lond—Jan. 21, 1898. No. 18119 A.

Pig Iron.

Notes on the French Pig Iron Industry. (Mittheilungen über die Französische Roheisen-industrie.) A tabular review of French iron production by departments, compared with that of other countries. 6000 w. Stahl und Eisen—Jan. 15, 1898. No. 18569 D.

The French Pig Iron Industry. From an article by Oscar Simmersbach in *Stahl und Eisen*. Information of the scarcity of material and inferior quality, &c. 1300 w. Am Mfr & Ir Wld—Feb. 11, 1898. No. 18357.

The Location of Pig Iron Production in the United States. Gives figures showing that the center of pig-iron production has passed to the Central West—the district of Pittsburg, Cleveland and Chicago. 1200 w. Eng & Min Jour—Feb. 26, 1898. No. 18681.

Plates.

Appliances for the Manufacture of Ship and Boiler Plates. Illustrated description of metal-working machines for billet-shearing, slab-shearing, and plate-shearing. 800 w. Ir & Coal Trds Rev—Jan. 28, 1898. No. 18279 A.

Review.

The Metallurgy of Steel in 1897. (La Métallurgie de l'Acier en 1897.) A. Boudon. A general review of the progress of the past year, dealing with details of new processes. Serial. 1st part. 4000 w. La Revue Technique—Jan. 25, 1898. No. 18529 D.

Stockholm Exposition.

The Stockholm Exposition and the Iron and Steel Trade of Sweden. James Douglas. Abstract of paper read at the Atlantic City meeting of Am. Inst. of Min. Engs. Describes the interesting exhibits of the iron and steel industries. 1500 w. Eng & Min Jour—Feb. 19, 1898. No. 18622.

Tool Steel.

Handling Tool Steel. S. K. Stupakoff. Urging the use of a reliable pyrometer, free intercourse between steel maker and steel worker, making it compulsory that an analysis should be furnished, and information on all points of service to the steel worker. 2400 w. Ir Age—Feb. 17, 1898. No. 18441.

MINING.**Accidents.**

Prevention of Accidents. An essay by M. G. Thomas, awarded first prize at an eisteddfod held at Oskaloosa, Iowa, Dec. 25, 1897. The best method of preventing accidents in and about the mines of Iowa. 2500 w. Mines & Min—Feb., 1898. No. 18350 C.

Automatic Doors.

Automatic Interlocking of Two Air-Doors. M. Botton. From a communication to *Comptes Rendus Mensuels* of the Société de l'Industrie Minérale, Saint Etienne. In the apparatus shown, the doors open in the same manner as two ordinary doors, although they cannot both be opened at the same time. 700 w. Col Guard—Jan. 28, 1898. No. 18273 A.

Improvements in Automatic Trap Doors for Mine Shafts. (Ueber Neuerungen an Brems-schachtverschlüssen.) Illustrating several devices for operating the doors automatically by the action of the cage; as used in a number of the mines of the Westphalia district. 2500 w. 2 plates. Glückauf—Feb. 5, 1898. No. 18572 B.

Capell Fan.

The Capell Fan. Some results obtained at a test conducted by the Berwind-White Coal-Mining Co., at Windber, Somerset Co., Penn. Ill. 3000 w. Mines & Min—Feb., 1898. No. 18352 C.

Explosives.

The Storage of Explosives. Robert Hunter. Gives sets of plans and specifications which have met with approval, and discusses the site and ventilation. Ill. 2500 w. Col Guard—Feb. 11, 1898. No. 18601 A.

The Various Systems of High Explosives, and the Conditions of Their Economical Application to the Different Methods of Working Coal in the British Collieries. L. T. O'Shea. The prize essay of this paper. Part first deals with the composition, safety, flames, &c. 3000 w. Ir & Coal Trds Rev—Feb. 4, 1898. Serial. 1st part. No. 18385 A.

Faults.

Faults. Albert Williams, Jr. Recovery of faulted beds and veins, relation of folds to faults and of both to metalliferous deposits, practical hints, &c. Ill. 6500 w. Mines & Min—Feb., 1898. No. 18349 C.

Fire.

The Fire in the Consolidated Cleophas Mine in Upper Silesia, March 3, 1896. (Der Brand in der Konsolidierten Cleophas Grube in Oberschlesien am 3 März 1896.) With an account of the successful use of steam and water for subjugating a stubborn fire in a gaseous mine. 2500 w. Glückauf—Feb. 12, 1898. No. 18573 B.

Locating Claims.

Location Before Discovery. R. W. Raymond. A consideration of the arguments opposing the location of claims on public mineral lands of the United States without proof of discovery within the claim of a valuable mineral deposit, with statements defining the situation. 1700 w. Eng & Min Jour—Feb. 12, 1898. Serial. 1st part. No. 18365.

Mexican Mining.

Mexican Methods of Mining. S. B. Newall. Abstract of a paper read before the Institution of Mining and Metallurgy, London. Describes the methods of working, and their adaptation to the majority of Mexican mines. 1700 w. Col Guard—Jan. 28, 1898. No. 18274 A.

Mining Appliances.

Engineering Appliances in Mining. C. M. Percy. Read before the Manchester (Eng.) Assn. of Engineers. The work of the mechanical engineer in the industry of coal mining, indicating the branches in which his influence has been most effectively applied, and the lines for further improvement. Discussion. 4000 w. Col Guard—Feb. 4, 1898. No. 18379 A.

Mining Camps.

Northwestern Mining Camps. W. B. Turner. A description of Stevens Co., and the Colville Reservation in Washington, U. S. A., and the Trail Creek and Nelson Districts, British Columbia. 2000 w. Mines & Min—Feb., 1898. No. 18351 C.

Mining Law.

Mining Law and Its Bearing on the Development of Mines and Mining Districts. Frank C. Loring. Paper read at meeting of the B. C. Assn. of Min. Engs. Historical review of laws in various lands regarding ownership and right to dispose of mines, reviewing quite extensively the conditions existing in the United States, with the special object of considering the state of affairs in British Columbia. 7500 w. Can Min Rev—Jan., 1898. No. 18085 B.

Mining Law in British Columbia, Mexico and the United States. Rossiter W. Raymond. A general summary by the secretary of the American Institute of Mining Engineers intended to afford a basis for comparison with other countries, and especially with the laws of South Africa. 2500 w. Engineering Magazine—March, 1898. No. 18591 B.

Provision for Dead Rents in Mining Leases. Explaining British law on this subject. 2400 w. Col Guard—Jan. 21, 1898. No. 18137 A.

United States Mining Laws, and Regulations Thereunder, Relative to the Reservation, Exploration, Location, Possession, Purchase and Patenting of the Mineral Lands in the Public Domain. The latest official compilation of Federal Mining Law. 3500 w. Min & Sci Pr—Feb. 19, 1898. Serial. 1st part. No. 18651.

Mining Life.

Recollections of California Mining Life. Reviews what is known of the occurrence of gold in California prior to Jan., 1848, gives interesting account of the finding of the gold as reported by various persons, and the effect of the discovery. Ill. 9800 w. Min & Sci Pr—Jan. 29, 1898. No. 18255.

Mining Methods.

Early Mining and Milling Methods in California. R. B. Noyes. Describes the primitive construction of a mill used in the early '50s. 1200 w. Min & Sci Pr—Jan. 29, 1898. No. 18256.

Mining Regulations.

The Mining Regulations for the Canadian Yukon. The new regulations governing placer mining and dredging of this district in Canadian territory. 4400 w. Eng & Min Jour—Feb. 5, 1898. No. 18220.

Respirator.

Respiratory Apparatus for Rescue Work in Mines. J. Mayer. From *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*. Considers the classification of rescue apparatus, its importance to the mining industry, and gives illustrated description of design constructed by O. Neupert's Successors (Vienna), in conjunction with J. Pilar. 2300 w. Col Guard—Feb. 11, 1898. No. 18602 A.

Shafts.

Warming the Air of a Damp Downcast Shaft; for Preventing the Formation of Ice. M. Petit. From a communication to the Société de L'Industrie Minérale. Reviews the methods in general use and their shortcomings, and explains method worked out by the writer, and apparatus used. Ill. 1700 w. Col Guard—Jan. 21, 1898. No. 18138 A.

MISCELLANY.

Albertite.

Notes on the Albertite of New Brunswick. Ill. John Rutherford. A description of the result of the mining operations at the Albert mine, which supports the opinion that the albertite was injected into an open fissure, when in a very fluid state. 2800 w. Can Min Rev—Jan., 1898. No. 18088 B.

Asbestos.

On the Strange Singularity of Color in Some Forms of Asbestos. Robert H. Jones. Contains information as to the colored varieties of asbestos, especially the blue variety which comes from the Cape of Good Hope. 4400 w. Can Min Rev—Jan., 1898. No. 18089 B.

Asia Minor.

Emery, Chrome-Ore and Other Minerals in the Villayet of Aidin, Asia Minor. W. F. A. Thomae. An account of some of the minerals occurring in this district, describing the general features and geology of the region. Ill. 4800 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18471 D.

Clays.

The Ultimate and the Rational Analysis of Clays and Their Relative Advantages. Heinrich Ries. A discussion of the rational analysis of clay, briefly referring to the ultimate analysis, giving table. 2000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18467 D.

College of Mines.

The Michigan College of Mines. M. E. Wadsworth. An account of the aim and work of this institution. 5300 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18473 D.

Engineering Education.

Some Statistics of Engineering Education. M. E. Wadsworth. Statistical tables containing data from 1874 to date, with running commentary calling attention to certain points. 4000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18472 D.

Geologists.

Eminent American Geologists. J. L. Norris. Read at meeting of Ohio Inst. of Min Engs. Briefly reviews the work undertaken by geologists, and gives brief sketches of American geologists of note. 2800 w. Am Mfr & Ir Wld—Jan. 28, 1898. No. 18102.

Limonite Pseudomorphs.

Note on Limonite Pseudomorphs from Dutch Guiana. R. W. Raymond. Description and analysis of specimens of peculiar pseudomorphs of limonite after pyrite, found in the auriferous deposits of the Saramacca district. 1700 w. Trans Am Inst of Min Engs—Feb., 1898. No. 18468 D.

Manganese.

A Peculiar Manganese Ore of the Amazon District. (Ein Eigenthümliches Manganerz des Amazonas-Gebietes.) Dr. F. Katzer. Describing a peculiar nodular form of Limonite, which is associated with Psilomelane and Pyrolusite, and which occurs in the Amazon valley in sufficient quantity to be of commercial value. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 22, 1898. No. 18574 B.

Ore Reserves.

Calculating and Recording the Value of Ore Reserves. John Clinice Little. Paper read before the British Soc. of Min. Students. Suggests the use of a slide-scale for calculations of value, cost, profit, or loss, illustrating the method of

working by an example. 2200 w. Can Min Rev—Jan., 1898. No. 18090 B.

Ores.

Lead and Zinc Ores. E. Hedburg. The manner of their occurrence and their geological relation to the coal area of Missouri. Ill. 1400 w. Mines & Min—Feb., 1898. No. 18346 C.

Petroleum.

The Petroleum Sources of the British Empire. Boverton Redwood. Abstract of a paper read before the Imperial Institute. Information of the various fields in the British Empire, and the value of the deposits. 4500 w. Col Guard—Feb. 4, 1898. No. 18381 A.

Salt.

Soóvár (Sóóvár). G. Harmancsok. A geological and historical account of the Soóvár salt mines in Galicia, in which electric power has recently been introduced. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 12, 1898. No. 18577 B.

The Salt Mines of the Alps at the End of the 19th Century. (Die Salzberge der Alpen am Ende des Neunzehnten Jahrhunderts.) A general review of the history of the Alpine salt industry, with an account of the geological conditions, the present output, and future prospects. Two articles. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 5, 12, 1898. No. 18576 E.

Soda Deposit.

Native Sodium Carbonate. W. P. Blake. Information concerning a deposit near the head of the Gulf of California, known as the Santa Helena Soda Deposit. 800 w. Eng & Min Jour—Feb. 12, 1898. No. 18366.

Statistics.

The Statistics of the Mineral Industries of France for the year 1896. (Statistique des Industries Minérales en France pour l'Année 1896.) An abstract from the official report, giving the data for coal and iron, as well as such other minerals as occur in France; together with condensed information concerning steam engines. 1500 w. Le Génie Civil—Jan. 15, 1898. No. 18509 D.

Tin Works.

Some Products Found in the Hearth of an Old Furnace, upon the Dismantling of the Trethellan Tin Works, Truro, Cornwall. Wm. P. Headden. The furnaces had probably been in use nearly one hundred years, and the ores melted in them were the usual Cornish tin-ores, carrying some arsenopyrite. 1400 w. Am Jour of Sci—Feb., 1898. No. 18128 D.

Tungsten Ores.

Tungsten Ores in N. S. W. Joseph E. Carne. Memoranda respecting the occurrence in this colony. No payable deposits have yet been discovered. 3800 w. Aust Min Stand—Jan. 6, & 13, 1898. Serial. 2 parts. No. 18417 A each.

United Kingdom.

Mineral Statistics. A criticism on the report of mineral statistics of the United Kingdom, discussing the method of presentation, &c. 3500 w. Builder—Jan. 22, 1898. No. 18162 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene Explosions. Surveys some of the principal accidents that have occurred, discussing the cause, and giving information. 1800 w. *Sci Am*—Feb. 5, 1898. No. 18170.

An Acetylene Gas Generator. Illustrated description of Kay's patent safe acetylene gas generators. 1400 w. *Col Guard*—Feb. 4, 1898. No. 18380 A.

Burners for Acetylene Gas. (Ueber Acetylenebrenner.) A. Weber. With diagrams and curves showing the illuminating efficiency of various burners adapted for use with acetylene. 2000 w. *Schweizerische Bauzeitung*—Jan. 29, 1898. No. 18557 B.

Address.

Inaugural Address Before the Southern District Association of Gas Engineers, England. R. Beynon. Deals with experiences met with in the Torquay gas-works. 6000 w. *Gas Wld*—Feb. 12, 1898. No. 18489 A.

Ammonia.

The Value of Sulphate of Ammonia Compared with Other Manures. Information gained at Lord Rosebery's experimental station at Dalmeny, from the series of agricultural experiments carried out on these grounds. 1700 w. *Jour of Gas Lgt*—Feb. 1, 1898. No. 18400 A.

Calcium Carbid.

Priority in the Discovery of a Commercial Method of Making Calcium Carbid. Arthur C. Fraser. Evidence in support of the statement that the discovery belongs to the United States. 3800 w. *Pro Age*—Feb. 1, 1898. No. 18177.

Chemical Processes.

Chemical Processes in Gas-Works. W. Leybold. Abstract of a lecture given at the general meeting of the Assn. of German Chemists at Hamburg. 2000 w. *Jour Gas Lgt*—Feb. 1, 1898. Serial. 2 parts. No. 18399 A each.

Conveyor.

The Brouwer Quenching Conveyor of the Gas Works at Saint-Quentin and Fontainebleau, France. Translated from *Journal des Usines à Gaz*. Illustrated account of operation. 500 w. *Pro Age*—Feb. 1, 1898. No. 18176.

Gas Improvements.

A Berlin Deputation. Abstract of the chief points of report given by a deputation sent on a circular tour to look into the question of coin meters and other improvements, particularly with reference to carburetted water gas. 2000 w. *Gas Wld*—Feb. 5, 1898. No. 18403 A.

Illumination.

Investigation of Diffused Illumination for School-rooms, Lecture Halls and Work-rooms by Means of Incandescent Gas Lights. F. Kermanner and W. Prausnitz. Investigates the proper distribution of lamps and the number which ought to be used. 2500 w. *Pro Age*—Feb. 1, 1898. No. 18178.

Incandescent Lighting.

Development of Incandescent Gas Lighting in the United States. D. Walter Brown. A concise history of the subject in title, with patents related thereto. 1300 w. *Pro Age*—Feb. 15, 1898. Serial. 1st part. No. 18414.

Leaks.

The Bouvier System for Detecting Leaks in Gas Mains. An illustrated description of this system which consists essentially of an inverted siphon placed in the gas main at the end of each section occupying a definite district. Describes the method of testing. 1200 w. *Pro Age*—Feb. 1, 1898. No. 18179.

Lighting.

Automatic Gas Lighting. (Gasfernzündung.) Discusses the various methods of turning on and lighting a number of gas burners from a distant point. Electro-magnetic valves and platinum sponge lighters are described. 2500 w. *Zeitschr d Ver Deutscher Ing*—Feb. 5, 1898. No. 18553 D.

Light Standards.

Some Remarks on Standards of Light. Remarks on the difficulties in photometry and the need of a more reliable standard by which to have the public gas supply valued. 1500 w. *Jour Gas Lgt*—Feb. 1, 1898. No. 18398 A.

Mantles.

Brilliance of Incandescent Mantles for Gas Lighting. C. Killing. Experiments and conclusions drawn of the results. 2000 w. *Gas Eng's Mag*—Feb. 10, 1898. No. 18679 A.

Philadelphia Gas Works.

The Arguments on the Appeal in the Matter of the Lease of the Philadelphia Gas Works. An examination of the arguments. 2000 w. *Am Gas Lgt Jour*—Feb. 7, 1898. No. 18246.

Purification.

Heat Developed During Purification. J. P. Gill. Presents a method of determining what will be the temperatures caused by the chemical reactions of the mass in the purifier and when removed therefrom. 1700 w. *Am Gas Lgt Jour*—Jan. 31, 1898. No. 18104.

The Progress of Purifier Construction and Operation, with an Instance. H. A. Mather. Describes and illustrates the system designed and erected by Henry M. Greene of the Preston (England) gas works. 2800 w. *Am Gas Lgt Jour*—Feb. 21, 1898. No. 18619.

Revivification.

The Heat of Revivification of Oxid. A critical review of paper by Herman Poole, published in the *Am. Gas. Lgt. Jour.* 1800 w. *Jour Gas Lgt*—Feb. 15, 1898. No. 18650 A.

Tar Still.

Lennard's Continuous Tar Still. From *The Chemical Trade Journal*. Illustrated description of an arrangement intended to do away with the odors. 800 w. *Pro Age*—Feb. 15, 1898. No. 18413.

Water Gas.

Developments in the Manufacture and Use of Water Gas. H. Dicke. States the advantages of water gas, discusses the Dellwik process and the manner in which water-gas works can meet the requirements of city use. 2300 w. Gas Wld—Jan. 22, 1898. No. 18159 A.

Welsbach.

The French Welsbach Patent Investigation. MM. Friedel and Bardy. Translated from the *Journal de l'Eclairage au Gaz*. Investigations of the specifications and patent claims of the Auer patents. 900 w. Pro Age—Feb. 1, 1898. No. 18180.

SEWERAGE.**Collector.**

The Collecting Sewer on the Right Bank of the Danube Canal at Vienna. (Der Sammelcanal am Rechten Ufer des Donau canals in Wien.) An account of the inspection of this important work by the Austrian Society of Engineers, with photographs illustrating work in progress. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Jan. 28, 1898. No. 18540 B.

Intercepting Sewers.

Intercepting Sewers in 12th St. and 22d St., Chicago. Illustrated description of the first two sewers of the intercepting system which is to carry the sewage to the Chicago River. 2000 w. Eng News—Feb. 24, 1898. No. 18659.

Pumping Engine.

A Sewage Pumping Engine at Charlottenburg, Germany. From *Zeitschrift d. Ver. Deutscher Ingenieure*. Illustrated description. 500 w. Eng News—Feb. 24, 1898. No. 18655.

Purification.

The Purification of City Sewage. (Die Klärung Städtischen Abwässer.) Abstract of a paper by Herr Brix, of Hamburg, reviewing the various sedimentation and precipitation processes, and emphasizing the importance of adapting the method to the local conditions. 1800 w. Gesundheits Ingenieur—Jan. 15, 1898. No. 18555 B.

The Purification of Sewage. Editorial on the experiments being tried at Exeter, Eng., with information concerning recent systems. 2500 w. Engng—Jan. 21, 1898. No. 18134 A.

Sewage Disposal.

Sewage Disposal and Stream Pollution in the Lower Passaic Valley, New Jersey. Editorial on the situation in the lower Passaic Valley, with some of the proposals for the solution of the question. 2000 w. Eng News—Feb. 24, 1898. No. 18658.

The Sewerage of Wimbledon, England. James H. Fuertes. Illustrates a system where none of the sewage, not even storm-water overflow, is allowed to flow directly into water courses. 1200 w. Eng Rec—Feb. 12, 1898. Serial. 1st part. No. 18360.

Sewage Works.

The Leyton Sewage and Destructor Works. Illustration of works, with description of process. 1300 w. Engr, Lond—Feb. 4, 1898. No. 18378 A.

STREETS AND PAVEMENTS.**Brick Pavements.**

Random Notes on the Construction of Brick Pavements. E. A. Kemmler. Reviews the principles of street construction as laid down by the different specifications of a number of the larger cities, pointing out the good and bad features. 2400 w. Munic Engng—Feb., 1898. No. 18121 C.

Westminster.

Westminster Improvement Scheme. Discusses the proposal for rebuilding a portion of the Westminster neighborhood on a large scale, the conditions of which are embodied in a Bill under the title of "The Victoria Embankment and Certain Street Improvements, etc." 3500 w. Builder—Jan. 29, 1898. No. 18289 A.

WATER SUPPLY.**By-Pass.**

The Ridgewood Reservoir By-Pass. Illustrated description of this work in Brooklyn. The by-pass main is 5-ft. in diameter. 900 w. Eng Rec—Feb. 26, 1898. No. 18672.

Coolgardie Pipe Line.

Plans of English Engineers for the Coolgardie Pipe Line. Editorial discussion of the plans proposed for a water supply to this mining district in Western Australia. The engineering problem is stated and discussed. 3000 w. Eng News—Feb. 17, 1898. No. 18460.

Croton Dam.

The Croton River Dam, New York Water Supply. Illustrated description of this extensive engineering work. 1700 w. Sci Am—Feb. 5, 1898. No. 18169.

Excavator.

Bomford and Evershed's Patent Excavator. Illustrated description of machine especially suitable for reservoir work, and applicable also to any situation where the spoil has not to be transported a great distance. 1200 w. Engr, Lond—Feb. 11, 1898. No. 18484 A.

Filtration.

The Albany Filtration System. Describes the 15,000,000 gallon covered sand-filter plant to be built at Albany, N. Y. 1500 w. Eng Rec—Jan. 29, 1898. No. 18148.

The New Sedimentation Basin and Masonry Covered Sand Filter Beds at Albany, N. Y. An illustrated description with specifications for filtering material, of what will be the largest water-purification plant in the United States. 1600 w. Eng News—Feb. 10, 1898. No. 18320.

Force Mains.

The Design of Force Mains. Describes a method of determining the most economical diameter of force mains used at Brockton, Mass. 1300 w. Eng Rec—Feb. 19, 1898. No. 18635.

Philadelphia.

Philadelphia Water Supply. Editorial on the situation of the water supply and the plans of the Schuylkill Valley Water Co. 900 w. Eng Rec—Feb. 19, 1898. No. 18631.

Pollution.

The Pollution of the Water Supply of Cumberland, Md., by a Paper Pulp Mill. Church-ill Hungerford. Describes the forms of contamination from the process used and gives brief summary of suit by the city of Cumberland, Md. 1400 w. Eng News—Feb. 10, 1898. No. 18319.

Pumping Engine.

A Special Water-Works Pump—Liverpool, England. Joseph Parry. Illustrated description of this unique $7\frac{1}{4}$ million-gallon engine. 1600 w. Eng Rec—Feb. 26, 1898. No. 18673.

Record System.

The Record System of the Water-Works Department, Detroit. Illustrates a method of keeping pipe records by note books and tracings. 2000 w. Eng Rec—Feb. 12, 1898. No. 18359.

St. Louis, Mo.

Water Works of St. Louis. Illustrated description of works for a city having an average daily consumption of 55,000,000 gallons. 1700 w. Fire & Water—Feb. 12, 1898. Serial. 1st part. No. 18344.

Water Rates.

The Chillicothe Water-Works Case. Henry Wollman. Reviews an important suit concerning water rates. 800 w. Eng Rec—Feb. 5, 1898. No. 18214.

The Denver Water-Rates Case. Abstract of an unusually important decision concerning rates to private consumers. 1100 w. Eng Rec—Feb. 26, 1898. No. 18674

Water Sources.

The Investigation of Subterranean Water Sources. (Recherche des Eaux Souterraines.) Discussing the geological conditions which govern the flow of waters within the earth and of the external indications by means of which they may be discovered. Serial. 1st part. 3000 w. La Revue Technique—Jan. 25, 1898. No. 18528 D.

MISCELLANY.**Bacteriology.**

The James Forrest Lecture on Bacteriology. A review of Dr. G. S. Woodward's address before the Institution of Civil Engineers. 2000 w. Eng Rec—Jan. 29, 1898. No. 18147.

Boston.

The Municipal Service of Boston. Francis C. Lowell. The article considers what we get from the city and what we pay for it, taking the city of Boston as an example. 7000 w. Atlantic M—March, 1898. No. 18609 D.

Destructors.

The Berlin Investigations of Dust-Burning. (Die Müllverbrennungs-Versuche in Berlin.) Abstract from the report of Messrs. Bohm and Grohn, with tabulated statement of the cost and performance of the various destructor furnaces tested. 3500 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1898. No. 18563 D.

Refuse.

The Cremation of Dust-Bin Refuse. Editorial on the discussion of George Watson's paper on refuse destructors, read before the Gloucestershire Engineering Society. 1500 w. Engng—Feb. 11, 1898. No. 18480 A.

RAILWAY AFFAIRS.**CONDUCTING TRANSPORTATION.****Accidents.**

Train Accidents in 1897. Tabulated report of the accidents for the year in the United States. 500 w. R R Gaz—Feb. 11, 1898. No. 18331.

European Railways.

An American Observer in Europe. E. L. Corthell. Names features of English roads superior to the United States, and compares American and European transportation methods. 1200 w. R R Gaz—Feb. 11, 1898. No. 18325.

Rating.

Tonnage Rating. L. R. Pomeroy. Deals with the methods of rating locomotives and the possibilities of reducing their relative consumption of coal. Also discussion. 15500 w. N. Y. R R Club—Jan. 20, 1898. No. 18343 D.

FINANCIAL.**Consolidation.**

Consolidation of the "Vanderbilts." Editorial on the proposed consolidation of the New York Central and Lake Shore and Michigan Southern, and other contemplated changes. 700 w. Ry Age—Feb. 4, 1898. No. 18221.

Japan.

Railway Enterprise in Japan. Extract from the *Japan Times*, showing the progress of railway enterprises in Japan during the year 1897. 900 w. Cons Repts—Feb. 17, 1898. No. 18452 D.

Motive Power.

Business Problems of the Motive Power Department. Robert Quayle. Extracts from a lecture delivered at Purdue Univ. Presents an idea of the expenses, and discusses the problems within the department named. 3700 w. R R Gaz—Feb. 18, 1898. No. 18465.

Prussia.

The Budget of the Royal Prussian State Railway Administration for 1898-99. (Der Etat der Königlich Preussischen Eisenbahn-Verwaltung für das Jahr 1898-99.) Giving tabular estimates for the coming year in comparison with those of the past, with details of proposed expenditures and operations. 8000 w. Stahl und Eisen—Feb. 1, 1898. No. 18570 D.

Railroad Building.

Railroads Building or Projected in the United States, Canada and Mexico. List of such enterprises as show signs of genuineness, either by

work in progress or by signs that it will soon be begun. 4000 w. R R Gaz—Feb. 11, 1898. No. 18329.

Yukon.

A Railroad to the Yukon. Extract from the *Ottawa Citizen*, concerning a new line of railway to this region. 700 w. Cons Repts—Feb. 4, 1898. No. 18198 D.

LEGAL AFFAIRS.

Commerce Regulation.

Proposed Changes in the Act to Regulate Commerce. Editorial discussion of the bill introduced in the Senate of the United States by Mr. Cullom. 1500 w. Ry & Engng Rev—Jan. 29, 1898. No. 18167.

Ownership.

J. H. Reagan on Government Ownership. Extract from a letter addressed to Congressman Kleberg of Texas. Unfavorable to government ownership, and also favoring legalizing "pooling." 900 w. Ry Age—Feb. 4, 1898. No. 18222.

MOTIVE POWER AND EQUIPMENT.

Coal Cars.

Coal Car, 60,000 lbs. Capacity; N. Y., N. H. & H. R. R. Illustrated description of cars presenting some interesting details. 900 w. R R Car Jour—Feb., 1898. No. 18333.

Seventy-Thousand Pound, Twin-Hopper Coal Cars. Illustrated detailed description. 600 w. R R Gaz—Feb. 4, 1898. No. 18227.

Coil Springs.

Coil Springs for Freight Cars. A report to the Central Railroad Club by Messrs H. C. McCarty, H. F. Ball, and J. R. Petrie. Considers spring space, type of spring, sizes, &c., and summary of recommendations. Ill. 1500 w. R R Gaz—Feb. 18, 1898. No. 18464.

Drawbar.

Yielding Continuous Drawbars for Railway Cars. (Die Nachgiebige Durchgehende Zugstange für Eisenbahnwagen.) H. von Borries. A paper read before the German Society of Mechanical Engineers advocating the introduction of the continuous drawbar of similar construction to that used in the United States. 3500 w. Glaser's Annalen—Jan. 15, 1898. No. 18564 D.

Driving Shoes.

Fitting Up Driving Shoes and Wedges. Ira A. Moore. Directions for the work with illustrations. 2200 w. Loc Engng—Feb., 1898. No. 18173 C.

Granite Car.

Special Granite Car. Illustrates and describes a car of special design. 400 w. R R Car Jour—Feb., 1898. No. 18334.

Kinetic Motor.

The Kinetic Motor. An illustrated description of an independent motor for railway and tramway service. 1400 w. Ry Wld—Feb., 1898. No. 18394 A.

Locomotives.

American Locomotives for Corea. Illustra-

tion and dimensions of locomotives to be built by the Brooks Locomotive Works. 600 w. Eng News—Feb. 24, 1898. No. 18660.

Brooks Locomotives for Japan. Illustrated description with dimensions. 800 w. R R Gaz—Feb. 25, 1898. No. 18663.

Compound Consolidation Locomotives for the Ogdensburg & Lake Champlain. Engraving with detailed description of the parts. 500 w. R R Gaz—Feb. 11, 1898. No. 18327.

Early Baldwin Locomotives on the Pennsylvania Railroad. C. H. Caruthers. Description, principal dimensions, and illustrations. 1300 w. Loc Engng—Feb., 1898. No. 18174 C.

Glasgow and South Western Four-Cylinder Locomotive. Illustration and particulars. 600 w. Loc Eng—Feb., 1898. No. 18172 C.

Large Locomotives. Editorial on the rapid development that has taken place in locomotive engineering in the last five years. 1600 w. Engr, London—Feb. 4, 1898. No. 18375 A.

Locomotive Laggings. Wallace W. Johnson. Extracts from a paper read at meeting of N. Y. R. R. Club. The importance of protecting the heat radiating surfaces of the American locomotive, and the coverings used. 1500 w. R R Gaz—Feb. 25, 1898. No. 18661.

Locomotives Supplied by British Firms to American Railroads. An account of the locomotives made for American roads in the early part of this century is given in part first. Ill. 2800 w. Engr, Lond—Jan. 21, 1898. Serial. 1st part. No. 18117 A.

Locomotive with Piston Valves—Norfolk and Western Railway. Information concerning a change of a compound to a single-expansion engine attended with interesting and valuable results. Ill. 1500 w. Am Eng & R R Jour—Feb., 1898. No. 18155 C.

Notes on the Determination of the Principal Dimensions of Locomotives. (Considérations Relatives à la Détermination des Dimensions Principales des Locomotives.) A comparison of the relations between speed, tractive power, train resistance and engine power, based on actual performances. 2500 w. Le Génie Civil—Feb. 5, 1898. No. 18515 D.

Richmond Ten-Wheel Passenger Locomotives—Southern Railway. Illustrated description of two very large and heavy passenger engines. 1000 w. Ry & Engng Rev—Feb. 19, 1898. No. 18628.

Standard Consolidation Freight Locomotive of the Atchison, Topeka & Santa Fé Railway. Illustrated detailed description of a design of John Player. 900 w. Ry & Engng Rev—Jan. 29, 1898. Serial. 1st part. No. 18165.

The Improved Heilmann Locomotive. (Die Neueren Heilmann Lokomotiven.) E. Wasowsky. A general illustrated description of the Heilmann electric locomotive with photographic views, plan, elevation, and section of truck. 3500 w. Elektrotech Zeitschr—Jan. 27, 1898. No. 18582 B.

Three-Cylinder Compound Locomotive for the Jura-Simplon Railway. (Die Dreicylindrige Verbundlokomotive der Jura-Simplon Bahn.) This engine is constructed with a single high-pressure cylinder between the frames, and two outside low-pressure cylinders. Twenty-five

of this type are now under construction for this road. 1 plate. 2000 w. Schweizerische Bauzeitung—Feb. 12, 1898. No. 18559 B.

Two New Grand Trunk Locomotives. Illustrated description of the 10-wheel passenger engines recently adopted as the standard, and principal dimensions of the new standard mogul freight engines. 700 w. R R Gaz—Feb. 11, 1898. No. 18326.

Postal Cars.

New Postal Cars, Chicago & Alton Railroad. Illustrated description of cars of improved design. 700 w. Am Eng & R R Jour—Feb., 1898. No. 18156 C.

School Car.

The Correspondence-School Car. Engraving and description of car for the International Correspondence School of Scranton, Pa. 700 w. Ry Age—Feb. 18, 1898. No. 18614.

Steel Cars.

The Advantages of Steel Cars. Discusses the economies of large steel cars, considering those intended for special service, and also for general interchange. 1600 w. Am Eng & R R Jour—Feb., 1898. No. 18157 C.

Wheel Testing.

Testing Car Wheels. From a pamphlet issued by the New York Car Wheel Works, of Buffalo, N. Y., entitled: "A Series of Tests Made by the P. H. Griffin Machine Works, of Buffalo, N. Y., on Nov. 8, 1895, with Special Qualities of Wheels Made by the New York Car-Wheel Works." Illustrated description. 2500 w. Foundry—Feb., 1898. No. 18262.

PERMANENT WAY, BUILDINGS AND FIXTURES.

Angle Plates.

High Carbon Angle Plates—Continuous Rails. A letter from A. Torrey, of the Michigan Central R. R., containing valuable facts concerning elastic track. 1000 w. R R Gaz—Feb. 18, 1898. No. 18463.

Ballasting.

Ballasting and Filling with the Rodgers Ballast Car. Illustrated description of car and manner of working. 1500 w. Eng News—Feb. 17, 1898. No. 18457.

Brazil.

The Railways of Brazil. Information relating to mileage, gauge, equipment, etc. 3300 w. Cons Repts—Feb. 14, 1898. No. 18340 D.

China.

Railways in China. (Eisenbahnen in China.) A general review of the progress of railway construction in China since 1875, with map. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 28, 1898. No. 18541 B.

Concord Shops.

Concord Shops—Boston & Maine Railroad. Description and plans of new, well-equipped shops. 2000 w. Am Eng & R R Jour—Feb., 1898. No. 18154 C.

Landslides.

Railway Building and Reconstruction Work

in Sliding Ground. (Ueber Eisenbahnbau und Reconstructionsarbeiten in Rutschterrain.) Soulay & Schmit. An important discussion of the nature of landslides in connection with the geological formation, with examples of original and reconstruction work in various parts of Europe. Three articles. 12000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Jan. 7, 14, 21, 1898. No. 18538 G.

New Line.

The Croydon and Redhill New Line. An account of the new section which will enable the London, Brighton, and South Coast Railway Co. to run entirely over its own lines, instead of using the six miles of the South-Eastern Railway. 1200 w. Engr, Lond—Jan. 28, 1898. No. 18275 A.

Rails.

Rails, Past and Present. E. C. Potter. Read before the Western Railway Club, Chicago. Reviews the early history of steel rails in America, and considers features, which, though apparently trivial, cause much annoyance and unnecessary expense. Ill. 2800 w. Ir Age—Feb. 17, 1898. No. 18442.

Railway Building.

Railway Building in the United States in 1897. Detailed statement by States showing the number of miles of track laid. 2500 w. Ry Age—Feb. 11, 1898. No. 18404.

Siberia.

Notes on the Extension of Railways in Russian Central Asia and Siberia. (Mittheilungen über den Ausbau der Eisenbahnen in Russisch-Central-Asien und Sibirien.) F. Theiss. With map showing the connection of the Transiberian railway with the general Russian system. 1800 w. Glaser's Annalen—Jan. 15, 1898. No. 18565 D.

Signals.

The Connections of the Siemens' Signal System. (Schaltung Siemens'scher Blockwerke.) O. Walzel. Giving schematic diagrams showing the application of the graphical method to the arrangement of block signal systems of Siemens' & Halske. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 21, 1898. No. 18539 B.

Interlocking Plant at Manchester, N. H. Brief illustrated description of the first interlockplant in the state of New Hampshire. 400 w. Ry Age—Feb. 11, 1898. No. 18405.

Interlocking Signals. An illustrated description of a system for interlocking signals and points of an ordinary third class station designed and patented by H. Sidney Jones, executive engineer. Rajputona-Malwa Railway. 800 w. Ind & East Eng—Jan., 1898. No. 18408 D.

Station.

New East End Canadian Pacific Railway Station at Montreal. Brief illustrated description. 450 w. Ry & Engng Rev—Jan. 29, 1898. No. 18164.

New Terminal Station at Duluth, Minn.; C., St. P., M. & O. Ry. Illustrated description. 500 w. Eng News—Feb. 10, 1898. No. 18318.

The New Grand Central. An illustrated article criticising the inconvenience and poor architecture of the station before alteration, and explaining the improvements made. 1500 w. Harper's Wk—Feb. 5, 1898. No. 18131.

Track Elevation.

Track Elevation in Chicago. Explains the work made necessary by an amendment extending the work about one mile. 1000 w. R R Gaz—Feb. 4, 1898. No. 18228.

Trunk Line.

The Kansas City, Pittsburg and Gulf R. R. Gives the history of the road, location, track, bridges, shops and yards, equipment, terminal, &c. Ill. 5000 w. Eng News—Feb. 17, 1898. No. 18462.

Tunnel.

The Protection of Railroad Traffic Through Tunnels. Charles Hansel. Describes an arrangement lately installed on the Chesapeake & Ohio R. R. for controlling the traffic between the stations of Lowell and Hildale, Va. A tunnel 6500 ft. long and a bridge 528 ft. long in a distance of 4.2 miles. An absolute block system. 2000 w. Eng News—Feb. 24, 1898. No. 18654.

Victoria.

Economic Railway Construction in Victoria. Maurice Edwin Kernot. Description of the work with analysis of cost per mile. 2300 w. Ind & East Eng—Jan., 1898. No. 18409 D.

STREET AND ELECTRIC TRAMWAYS.

Accident Blanks.

Accident Blanks in New Orleans. G. H. Davis. Copy of blank form used by the Canal and Claiborne Railroad Company, with explanatory notes. 1200 w. St Ry Jour—Feb., 1898. No. 18192 D.

Accidents.

Street Railway Accidents. Henry A. Robinson. Abstract of paper read before the Metropolitan St. Ry. Employés' Assn. of New York. Gives a short synopsis of the claim and investigating departments of Metropolitan St. Ry. of N. Y., classifies the accidents and examines the causes, and gives brief advice to conductors. 3300 w. St Ry Jour—Feb., 1898. No. 18193 D.

Accounting.

Open Questions before the Committee on a Standard System of Street-Railway Accounting. A. O. Kittredge. A report of the discussion by the committee appointed by the Assn. of St. Ry. Accountants at Niagara Falls. 3000 w. St Ry Jour—Feb., 1898. No. 18196 D.

Accumulators.

Accumulator Roads. (Akkumulatorenbahnen.) E. Hauswald. A description of the use of the Pollak accumulator system in Frankfort, with load diagram and details of cost and management. 1800 w. Elektrotech Zeitschr—Jan. 20, 1898. No. 18581 B.

Boosters.

Boosters for Street Railways. Describes in-

TRAFFIC.

Earnings.

January's Large Railroad Earnings. Reports even a better showing than the last month of 1897, and gives tables of comparison. 1500 w. Bradstreet's—Feb. 12, 1898. No. 18354.

Results of the Railroad Year. A comparatively favorable report of the roads of the United States, for the year 1897. 1000 w. Bradstreet's—Feb. 19, 1898. No. 18454.

The Pennsylvania's Latest Earnings. An examination of the statement of this road for Dec., 1897. Shows large increase in gross and net earnings, and the effect on railroad business of the revived activity of trade. 800 w. Bradstreet's—Feb. 5, 1898. No. 18226.

Fares.

British Railway Fares. William J. Stevens. Gives a careful comparison between English and American passenger fares. The very low excursion rates in England are compared with the higher American rates, and the tendency of competition to provide extended facilities is noted. 4000 w. Engineering Magazine—March, 1898. No. 18595 B.

Traffic Bureau.

The Traffic Bureau. A. J. Vanlandingham. Substance of an address before the Business Men's League of St. Louis. Explains the work and value of such organizations. 1400 w. Ry & Engng Rev—Jan. 29, 1898. No. 18166.

stallations on various roads. Ill. 3300 w. St Ry Rev—Feb. 15, 1898. No. 18450 C.

Brooklyn Bridge.

Trolley-Car Service on the Brooklyn Bridge. Illustrated description of the construction methods employed for the track and overhead equipment. 1000 w. Elec Wld—Feb. 5, 1898. No. 18223.

Changing Power.

Changing a Cable Street Railway to a Conduit-Electric System in Washington, D. C. Describes and illustrates the work. 1800 w. Eng News—Feb. 24, 1898. No. 18653.

Connecticut.

Operating Expenses of Connecticut Railways. From the annual report of Railroad Commissioners indicating a not very prosperous condition. 3500 w. St Ry Rev—Feb. 15, 1898. No. 18449 C.

Electric Tramways.

Electric Tramway Design. Alex McCallum. Considers some of the general principles applying them to a simple line and indicating how their scope may be extended. 4000 w. Ry Wld—Feb., 1898. No. 18395 A.

Electric Traction in America. Louis Bell. A general review of the improvement in American tramway practice, the different systems, costs and future prospects. 3500 w. Ry Wld—Feb., 1898. No. 18396 A.

Mechanical Features of Electric Traction.

Philip Dawson. Read before the Institution of Mechanical Engineers, England. Introductory remarks showing the importance of the subject, with discussion of special features entering into the design and construction of the system. Ill. 2500 w. *Elect'n*, Lond—Jan. 28, 1898. Serial. 1st part. No. 18294 A.

Exposition.

Competition for an Electric Railway in the Paris Exposition of 1900. (*Concours pour un Chemin de Fer Electrique à l'Interieur de l'Exposition de 1900.*) Giving the conditions for the competition, and a brief description of the five plans already submitted. 1200 w. *Le Génie Civil*—Jan. 8, 1898. No. 18507 D.

Foresight.

The Value of Foresight in Engineering. Editorial on the announcement of the Third Avenue R. R. Co. of New York City, that electric traction on the conduit system will be substituted for the cable. 1400 w. *Eng News*—Feb. 3, 1898. No. 18204.

Glasgow Subway.

The Glasgow District Subway. Gives a few details of the general features, the schemes that led up to it, and the reasons for the form it has finally taken, also describing the electric gear used. Ill. 2800 w. *Elec Eng*, Lond—Jan. 21, 1898. Serial. 1st part. No. 18160 A.

Kansas City.

System of the Metropolitan Street Railway Company of Kansas City. Illustrated detailed description of a system which embraces nearly all the cable and electric lines of Kansas City, Kan., and Kansas City, Mo. 3700 w. *St Ry Jour*—Feb., 1898. No. 18190 D.

Locomotive.

See Railway Affairs, Motive Power.

London Underground.

London Underground Electric Railroads. Brief review of the lines in operation or in a forward state of construction. 1500 w. *R R Gaz*—Feb. 4, 1898. No. 18230.

The London "Underground" and Electrical Equipment. The conclusions of the commission appointed by Parliament to inquire into the ventilation of the tunnels of the Metropolitan steam line, with the general characteristics, details of trains, &c. 2200 w. *R R Gaz*—Feb. 25, 1898. No. 18662.

Massachusetts.

The Report on the Relations of Street Railways and Municipal Corporations in Massachusetts. Text of report of the special committee. 12000 w. *St Ry Rev*—Feb. 15, 1898. No. 18451 C.

Mountain Road.

Three-Phase Electric Road from Zermatt to the Gornergrat, Switzerland. (*Chemin de Fer Electrique à Courants Triphasés de Zermatt au Gornergrat.*) A very fully illustrated account of

this important electric rack railway. 1 plate. 4500 w. *Le Génie Civil*—Jan. 22, 1898. No. 18510 D.

The Jungfrau Railway. L. Bayly. Illustrated description of this wonderful electrical engineering work. 1600 w. *Elec Eng*, N. Y.—Feb. 24, 1898. No. 18641.

Municipal Ownership.

Municipal Ownership of Street Railways in Massachusetts. A report against it by a special investigation committee. 2000 w. *Elec Eng*, N. Y.—Feb. 10, 1898. No. 18305.

Pittsburgh.

Important Changes Proposed in Pittsburgh. An outline of the important changes in regard to the generation of power, made necessary by the recent consolidation of several companies. Ill. 1000 w. *St Ry Jour*—Feb., 1898. No. 18195 D.

Rapid Transit.

Rapid Transit in New York. Editorial on the privileges asked by the Manhattan Ry. Co. in the way of extending and improving its system. 1300 w. *R R Gaz*—Feb. 4, 1898. No. 18231.

Shops.

The Chester Park Shops of the Cincinnati Street Railway Company. Illustrated description of the fine shops built since the consolidation of the street-railway companies into one system. 2000 w. *St Ry Jour*—Feb., 1898. No. 18191 D.

Storage Battery.

Tests of a Storage Battery Electric Railway Power Plant. An account of tests of the power plant and batteries of the Englewood & Chicago Electric Ry., made by George A. Damon. 3000 w. *Eng News*—Feb. 3, 1898. No. 18205.

Test of the Chicago Storage Battery Road. A brief sketch of the history of the company and description of the equipment, with account of test. Ill. 6800 w. *St Ry Rev*—Feb. 15, 1898. No. 18448 C.

Street Railroad Laws.

Proposed Massachusetts Street Railroad Laws. A synopsis of the two bills embodying new laws and amendments to the old ones. 1700 w. *R R Gaz*—Feb. 25, 1898. No. 18665.

Tunnel.

Views in the Completed Portion of the Boston Rapid-Transit Tunnel. Interesting views of this subway, showing its attractive appearance, with some information relating to tracks, lighting system, station equipment, &c. 1500 w. *Eng News*—Feb. 3, 1898. No. 18201.

Worm Gearing.

Worm Gearing and Railway Traction. A defence of the method of connecting railway motors to car axles by means of worm gearing. 1100 w. *Am Elect'n*—Feb., 1898. No. 18244

BOOKS OF MONTH



MECHANICAL DRAFT. A Practical Treatise. B. F. Sturtevant Co., Boston, Mass. Sturtevant Engineering Co., London. 1898.

Although this handsome volume bears the imprint "Catalogue No. 98," it is by no means a trade catalogue in the ordinary acceptance of the term, but in fact a practical treatise of much value upon a subject concerning which there is elsewhere but little information available. The title in itself is hardly an indication of the real contents, since the earlier chapters form a treatise upon the generation of steam, beginning with water and its properties, and discussing successively steam, combustion, fuels and fuel efficiency, boiler efficiency, and rate of combustion, at which point the general subject of draft and its various forms is taken up.

In these early chapters there is a mine of information of great value, thoroughly up to date, collected from sources of the highest authority and tabulated in a very convenient manner, and while in the later portion of the book the advantages of the Sturtevant blower are set forth in connection with the production of mechanical draft, no attempt is made to introduce any form of advertising, and care has been taken to eliminate entirely the element of personal prejudice.

The subject of the advantages of mechanical draft as compared with what has rather oddly been termed "natural" draft is one which is receiving increased attention in many directions, and, from being considered merely as an alternative method, it is beginning to be advocated by many engineers as preferable for nearly all locations and circumstances. Under these conditions such a treatise as that which is before us should be in the library of every mechanical engineer who is interested in steam generation, as the best and, in fact, the only compendium of information relating to mechanical draft yet published.

We desire to take this occasion to commend the able manner in which Mr.

Walter B. Snow, who, we understand, is the author of the work, has performed his task, especially in the admirable arrangement of the tabular information.

THE "ELECTRICIAN" ELECTRICAL TRADES DIRECTORY, London: The Electrician Printing and Publishing Company, Limited. 1898.

The sixteenth year of this standard trades directory appears fuller than ever with valuable reference information and data relating to the electrical and allied industries.

The biographical section, which has always been noted for its fulness and accuracy, particularly in regard to contemporaneous scientific men, is this year more complete and valuable than in previous editions; while the main portion of the work, the directory of home, foreign, and colonial workers and dealers in the wide field covered by the electrical trades, is indispensable to all who are engaged in this growing branch of commerce and industry.

BOOKS RECEIVED.

The Marine Steam Engine. A Treatise for Engineering Students, Young Engineers, and Officers of the Royal Navy and Mercantile Marine. By the late Richard Sennett and Henry J. Oram. London, New York and Bombay: Longmans, Green & Co. 1898.

La Photographie et l'Etude des Nuages. Par Jacques Boyer. Paris: Charles Mendel. 1898.

Die Knickfestigkeit in Theorie, Versuch und Praxis. Vortrag des Herrn Fritz V. Emperger, und Discussion hierzu. Wien: Sonderabdruck aus der Zeitschrift des Oesterr. Ingenieur- und Architekten-Vereines. 1897.

The Pneumatic Despatch Tube System of the Batcheller Pneumatic Tube Co., also Facts and General Information Relating to Pneumatic Despatch Tubes. By B. C. Batcheller, B. Sc. M. E. Philadelphia: J. B. Lippincott Co. 1897.

Proceedings of the South Wales Institute of Engineers, Vol. 20, No. 6, containing papers by Mr. Hort Huxham on "Some Local Disturbances in Anthracite Collieries" and one by Mr. E. Cottam on "Coal Getting Without Blasting"; also full discussion on Prof. Galloway's paper on "Subsidence Caused by Workings in Mines."

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

Ingersoll-Sergeant Drill Co., New York. = Advance Sheets. Catalogue No. 41, illustrating and describing mining, tunneling, and quarrying machinery. Descriptive tables of the four types of rock drills made by the firm are given, together with directions for ordering and numerous handsome illustrations of practical applications.

General Electric Company, Schenectady, N. Y. = A Modern Gear Plant. A neat little pamphlet describing and illustrating the gear making plant at Lynn for the manufacture of steel gears and pinions for electric traction work.

Lincoln Iron Works, Rutland, Vt. = Circular No. 81; containing handsome illustrations of machines for planing stone; single and double platen planers are shown of capacity up to $8 \times 4 \times 14$ feet.

The International Correspondence Schools, Scranton, Pa. = Pamphlet catalogue of letters of endorsement by 88 students, all of whom testify to the value of the correspondence method of instruction.

Baker & Co., Newark, N. J. = Pamphlet catalogue of utensils of platinum for chemical and industrial use; including acid stills, dishes, pans, crucibles, &c., together with valuable data concerning platinum, tables of weights, electrical resistance, and notes concerning the care of platinum articles.

Vulcan Iron Works Co., Toledo, Ohio. = Descriptive Pamphlet of the special trench steam shovel, or back-action excavator; with photographs of the machine in action, and data concerning capacity and speed of operation.

The Ridgely & Johnson Tool Co., Springfield, Ill. = Pneumatic hammers for chipping, calking and riveting; also yoke and pocket pneumatic riveters for structural, tank and stack riveting in place.

Fraser & Chalmers, Chicago. = Riedler Pumps, Compressors and Blowing Engines. A valuable descriptive catalogue of the Riedler system, giving its history, with valve details, and illustrations of many important installations of these improved pumping engines. The data of tests form important engineering records for permanent reference.

The Risdon Iron Works, San Francisco, Cal. Catalogue No. 7. Air Compressing Machinery and Improved Rock Drills. Illustrating many varieties of compressors both simple and compound; operated by Corliss engines, Risdon water wheels or belt or rope transmission. Valuable tables and formulae are appended.

Montgomery & Co., New York. = The Tool Catalogue. An illustrated catalogue and price list of supplies, tools and machinery for all branches of the mechanical trades; including small tools and supplies of every kind for factories, machinists, contractors and railroads.

The Frasse Company, New York. = Catalogue of Machinery, Tools and Supplies, covering a very

extensive line of small tools for machinists' use, with prices and discounts.

Brown & Sharpe Mfg. Co., Providence, R. I. = Catalogue and price lists of universal and plain milling machines, grinding, screw, and tapping machines; also gear cutters and small tools. The scales, standard rules, squares and other products of Darling, Brown and Sharpe are also fully shown.

La Favorite Rubber Mfg. Co., Paterson, New Jersey. = Catalogue of specialties, including steam hose, Perry's sheet packing, gaskets, valve stem packing, valve washers, and gauge-glass washers.

W. & L. E. Gurley, Troy, N. Y. = Gurley's manual of engineering and surveying instruments, being the thirty-second edition of this well-known descriptive catalogue of surveying instruments, enlarged to include the latest products of the firm.

Charles E. Billin & Co., Chicago, Ill. = Catalogue of machinery and supplies for mines and mills, representing the products of a number of manufacturers. To be issued as a serial, monthly.

New Rapid Dry Kiln Co., Baltimore, Md. = Catalogue describing the patent "humid-pressure" system for drying lumber thoroughly and effectively. Describes numerous installations, and shows the advantages over the old methods.

Goheen Manufacturing Company, Canton, Ohio. = Pamphlet describing the carbonizing coating for the protection of iron and steel, with a large number of testimonials as to its suitability for various uses.

Hendrie & Bolthoff Manufacturing Co., Denver, Colorado. = General catalogue of mining and mill machinery, and railway supplies. Especially full as regards mining machinery, for all branches of work, representing the products of many standard firms.

B. F. Sturtevant & Co., Boston, Mass. = Catalogue No. 99. Steel Pressure Blowers. An exhaustive catalogue of the Sturtevant pressure fan blowers, giving also methods of test, showing superiority of fans over rotary blowers, and valuable reference tables of velocity, volume and horse power. Tables of pressure and air friction are also given.

The Meriden Machine Tool Co., Meriden, Conn. = Illustrated catalogue and price list of forming lathes and special tools for the economical production of brass goods, silver plated ware, and casket hardware.

Sheffield Car Co., Three Rivers, Mich. = Light Cars. A handsomely illustrated catalogue of velocipede, odometer, and other hand cars, as well as a variety of light cars for general service, and also equalizing electric-motor trucks.

Jones & Lamson Machine Co., Springfield, Vermont. = A beautiful specimen of special catalogue work, devoted to the production of screw threads by the use of the Hartness automatic die in the flat turret lathe.

THE
ENGINEERING MAGAZINE

VOL. XV.

MAY, 1898.

No. 2.

THE DEVELOPMENT OF THE TORPEDO-BOAT
DESTROYER.

By John Platt.

THE torpedo-boat destroyer has been much written about in the daily papers for the past few weeks, and has become of general interest from the fact that Spain is known to possess a number of the very fastest and latest of these useful little boats, which it procured from the Scotch yards. The United States, unfortunately, have not a single one afloat, and are not likely to have for some months to come, when one is expected to be completed. Three others are building, but on March 1 these were but one-tenth finished.

The question has often been asked: What is a torpedo-boat destroyer,—or “destroyer,” as it is generally called,—and what functions will it be called upon to perform in war? The special purpose of its English designers was to construct a vessel capable of destroying the enemy’s torpedo boats. Up to the present time it has also been so arranged that it can be used as a torpedo boat, the usual tubes being fitted for discharging torpedoes against the enemy’s ships.

For its special purpose it must have a greater speed than the ordinary torpedo boat, must be capable of maintaining this high rate of speed in a heavy sea-way, and, finally, must be a suitable platform for carrying quick-firing guns heavy enough to sink other torpedo boats or “destroyers.” These should not be less than six-pounders, and at least one twelve- or fourteen-pounder has always been added.

It is both instructive and interesting to sketch the gradual development of the latest “destroyer” from the original torpedo boat. The first torpedo boat on the lines of those now in use was designed and built for the Norwegian government by Messrs. Jno. I. Thornycroft & Co., in 1873, at their yards in Chiswick, England. This boat attained a speed of 15 knots an hour; she was 57 feet long, of

Copyright, 1898, by John R. Dunlap.



ROYAL SPANISH TORPEDO VESSEL "ARIETE." 97 TONS DISPLACEMENT. 1600 I. H. P.

147½x14½x4.9 ft.; speed 26 knots. John I. Thornycroft & Co., Chiswick, London.

16 tons displacement, and developed 90 i. h. p. The next development was in 1877, when the *Lightning* was built by the same firm for the British government. This boat was 84 feet long, of 27 tons displacement, and developed 460 i. h. p., and a speed of 19.4 knots per hour. In 1878 Messrs. Yarrow raised this speed, with about the same size of boat, to 21.93 knots; in 1880, to 22.16 knots; in 1885, to 25 knots. In 1887 Thornycroft built a much larger boat,—the *Ariete*, for the Spanish government. She was 148 feet long, of 97 tons displacement, and, with 1,600 i. h. p., made 26.1 knots per hour. She carried four three-pounder quick-firing guns, and two torpedo tubes. Torpedo boats of about this size and speed have also been built by Herreshoff, Normand, Schichau, and others, and represent the usual run of the first-class torpedo boats owned in large numbers by the different navies of the world.

It was first decided to build boats of the "destroyer" class in 1885; those suggested were about the same size and speed as the torpedo boats, and carried two three-pounder quick-firing guns, and three double-barrel Nordenfeldt guns as an alternative to torpedo tubes. These boats, at the time they were built, were called "torpedo-boat catchers." As their speed-capacity was only 20 knots per hour, they were not worthy of this name. From 1886 to 1893 a series of torpedo gunboats, which were generally supposed to have been built as "catchers," were turned out. We have the assurance of Capt. Eard-



RELATIVE SIZE OF TORPEDO BOATS, TORPEDO-BOAT DESTROYERS, AND TORPEDO GUNBOATS.

ley-Wilmot, R. N., and Lord Geo. Hamilton that the British naval authorities, in making this class of boat, did not at all consider them "catchers," but simply torpedo gunboats, capable of going to sea in any weather.

Their development will be sketched here, as they form the link between the attempt in 1885 to build a sea-going boat faster than the torpedo boat, and the successful issue thereof in 1894.

The type built in 1886

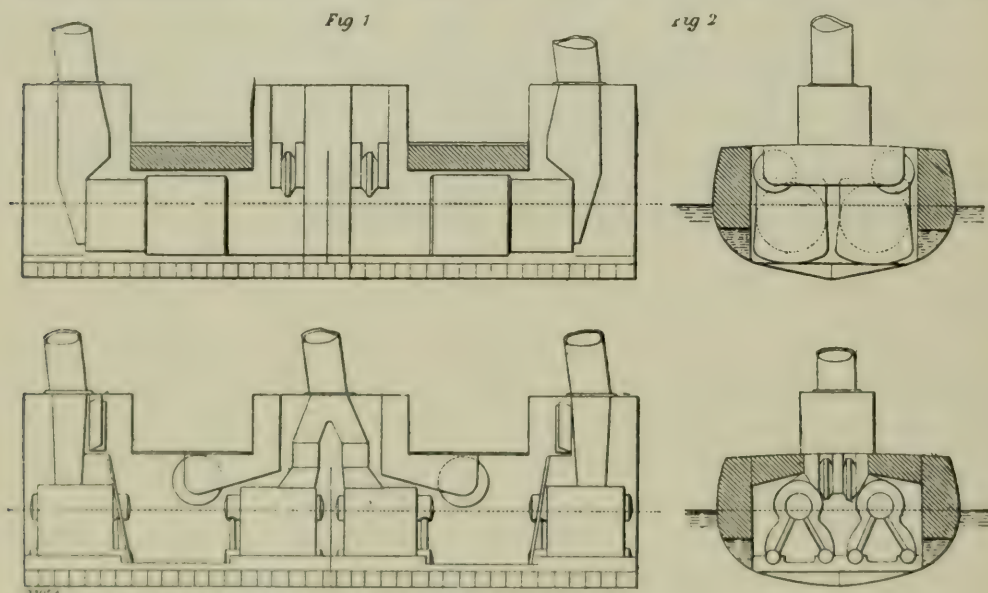
was represented by the Rattlesnake. These boats were of 550 tons displacement, and attained a speed of 19 knots with engines of 2,700 i. h. p. They were armed with one four-inch gun, and six three pounder quick-firing guns, besides torpedo tubes.

It was found necessary to increase the size of the next series of boats, so that more power might be obtained ; consequently the displacement was increased to 735 tons. Between 1888 and 1890 a considerable number of these boats were built by the British govern-



U. S. TORPEDO BOAT "CUSHING." 105 TONS DISPLACEMENT. 1720 I. H. P.
138 ft. 9 in. x 14 ft. 10 in. x 5 ft. 3 in. ; speed 22 knots. Herreshoff, Bristol, R. I.

ment, commencing with the Sharpshooter. Their length is 230 feet, beam 27 feet, draught 8 feet 3 inches, displacement 735 tons, and their engines were to develop 4,500 i. h. p.; but, difficulties being experienced with the locomotive boilers, which up to this time had been used generally in boats of this class, it was found impossible to obtain more than 3,700 i. h. p., and the speed did not exceed 20 knots per hour. It was with considerable difficulty that even this power was obtained. This led in 1892 to eleven new vessels of this type, increased in displacement to 810 tons, chiefly to provide more accommodation for the machinery. Ten of these boats were fitted



A COMPARISON OF LOCOMOTIVE AND WATER-TUBE BOILERS.

The water-tube boilers give 1000 h.p. more, with less weight, and in the same space.

with locomotive boilers, which developed on an average 3,700 h. p., giving a speed of $19\frac{1}{2}$ knots. The remaining boat, the *Speedy*, built by Jno. I. Thornycroft & Co., is of peculiar interest from the fact that she was the first large boat in the navy fitted with water-tube boilers. The sketch plan on this page shows the relative spaces taken by the locomotive and water-tube boilers. The large excess of power obtained by the boilers in the *Speedy* undoubtedly led in a large measure to the working out of the present form of "destroyer."

The *Speedy*, of which a very good idea can be obtained from the illustration on page 193, is 230 feet long, 27 feet beam, 8 feet 8 inches draught, and 810 tons displacement. She was fitted with eight Thornycroft boilers, each having 25.5 square feet of grate surface, and 1,840 square feet of heating surface. On trial, 4,700 h. p. was easily developed, and with this a speed of $20\frac{1}{2}$ knots was obtained. At a later date, in ordinary service, after the navy stokers



H.M.S. SPEEDY—TORPEDO GUNBOAT. 810 TONS DISPLACEMENT. 4500 I.H.P.,
FORCED DRAUGHT.

230x27x8 $\frac{1}{3}$ ft.; speed 20 $\frac{1}{2}$ knots. John I. Thornycroft & Co.

had become accustomed to the new type of boiler, there was no difficulty in developing 5,000 h. p. Thus an increase of 1,300 h. p. had been accomplished, with a reduction of 20 tons in the weight of the boilers. The i. h. p. developed per ton of boiler averaged 43.9. Under natural draught, on a trial lasting 20 hours, the coal consumed was only 1.58 pounds per i. h. p., which compares favorably with the best marine practice.

In further effort to obtain speed, boats of the "Halcyon" class, of 1,070 tons displacement, were built, but did not prove very successful. During all this time the speed of the ordinary torpedo boat had rapidly increased, but there had been no corresponding increase in the speed of the catchers. This led to the working out, in 1893, by Thornycroft and Yarrow, respectively, of the *Daring* and *Havock*, the first of the "destroyers" proper. The *Daring* is 185 feet long, 19 feet beam, 6 feet 3 inches mean draught, and 220 tons displacement. The engines on trial developed 4,735 i. h. p., and a speed of 29.268 knots per hour. The *Havock* attained a speed of 27.6 knots per hour on her trial trip. The armament consists of one twelve-

TORPEDO-BOAT DESTROYERS.



H.M.S. "DARING"—TORPEDO-BOAT DESTROYER. 220 TONS DISPLACEMENT.
4735 I.H.P.

185x19x6¼ ft.; speed 29.26 knots. Built by Thornycroft.

pounder quick-firing gun, mounted on the conning tower, and five six pounder quick-firing guns, four on the broadside and one on the centre line aft.

The next development was in the Boxer class, in which the boats were slightly increased in size. The length was 200 feet, beam 19 feet, mean draught 7 feet, and displacement 250 tons. The engines developed 4,700 h. p, and a speed of 29.314 knots was obtained,—an average of six runs on the measured mile.

The present standard and most economical English "destroyer" is represented by the "Desperate" class, designed by Thornycroft.



H.M. TORPEDO-BOAT DESTROYER "HAVOCK." 240 TONS DISPLACEMENT.
3400 I.H.P.

180x18.5x7.5 ft.; speed 27.6 knots. Varrow & Co., Poplar.



H.M. TORPEDO-BOAT DESTROYER "BOXER." "BRUISER" ASTERN. 250 TONS DIS-
PLACEMENT. 4700 H.P.

200x19x7 $\frac{2}{3}$ ft.; speed 29.31 knots. Built by John I. Thornycroft.

The requirements are that a speed of 30 knots shall be maintained for three hours, with a load of 35 tons on board, and with a coal consumption of not more than 2 $\frac{1}{2}$ pounds per i. h. p.

The Desperate is 210 feet long, 19 feet 6 inches beam, and 7 feet 2 inches mean draught, with trial displacement of 275 tons. Twin screws are driven by engines with high pressure cylinders 20 inches diame-



H.M. TORPEDO-BOAT DESTROYER "ARDENT." 265 TONS DISPLACEMENT. 4300 I. H. P.

200x19x7 ft.; speed 27.8 knots. John I. Thornycroft & Co.



TORPEDO-BOAT DESTROYER "HORNET" OVERTAKING TORPEDO GUNBOAT "SEA GULL."

ter, intermediate 29 inches two low-pressure 30 inches diameter all by 18 inches stroke, the revolutions varying between 390 and 400. Three water-tube boilers, with 63.5 square feet of grate surface and 4,020 square feet of tube surface, furnish steam at 220 pounds pressure. On the three hours' trial a speed of 30.5 knots per hour was attained, with a coal consumption of 2.43 pounds per i. h. p.

These boats carry the standard English "destroyer" armament of one twelve-pounder quick-firing gun, and five six-pounder quick-firing guns, with two torpedo tubes for eighteen-inch Whitehead torpedoes.



H.M. TORPEDO-BOAT DESTROYER "SPARROWHAWK." 300 TONS DISPLACEMENT.
6000 I.H.P.

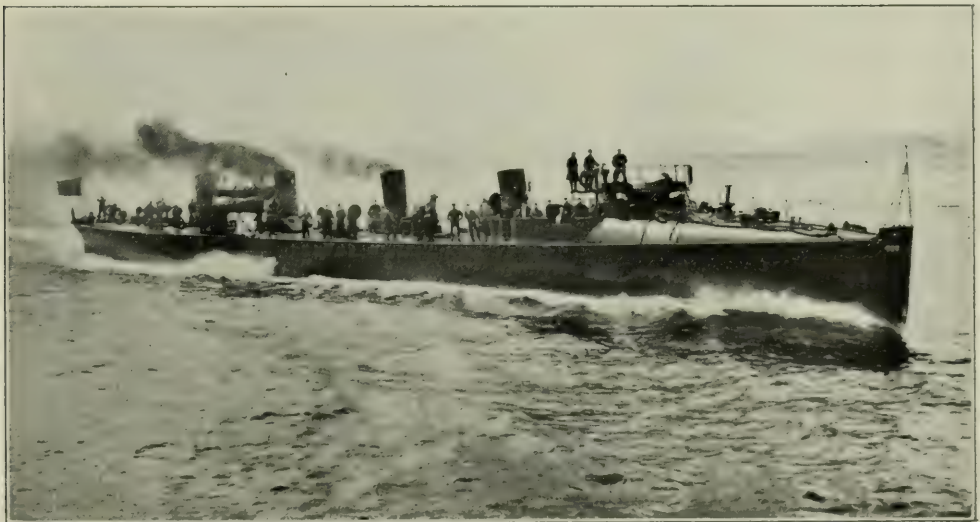
210x21 785.3 ft.; speed, 30 knots. Laird Bros., Birkenhead.



U. S. DYNAMITE CRUISER VESUVIUS. 930 TONS DISPLACEMENT. 3794 I.H.P., FORCED DRAUGHT.

Length 251.9 ft., beam 26.5, draft 10.7; speed 22.5 knots. Built by Wm. Cramp & Sons, Phila., Pa.

They have proved, after the severest possible trials in a heavy sea-way, thoroughly efficient sea boats and in every way adapted to the carrying of their guns and torpedo tubes. This is particularly referred to here, as later it will be touched upon in connection with the question of



TORPEDO-BOAT DESTROYER OF THE "QUAIL" TYPE. 300 TONS DISPLACEMENT. 6000 I.H.P.

210x21.7x5.3 ft.; speed 30 knots. Laird Bros.



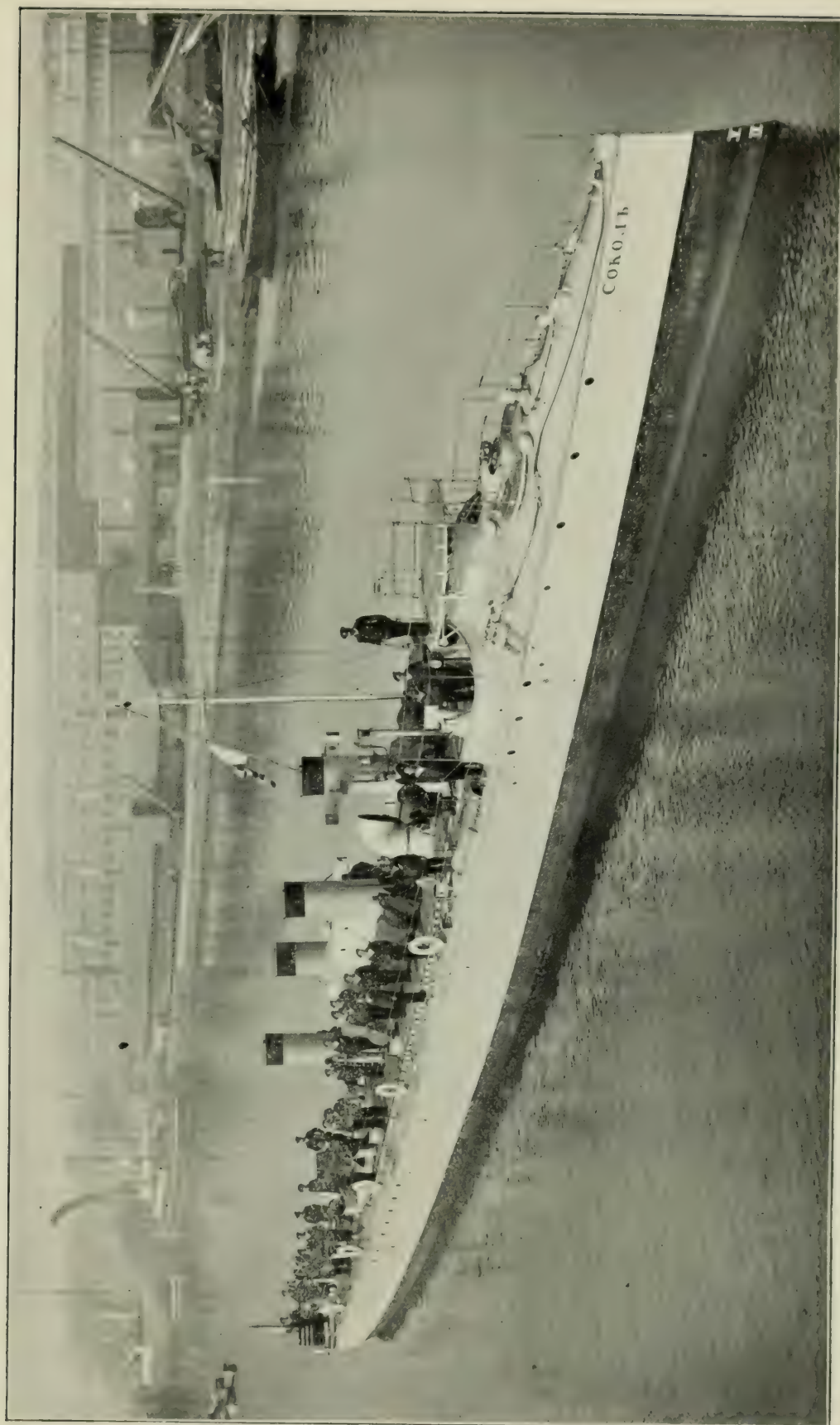
U. S. TORPEDO BOAT "ERICSSON." 120 TONS DISPLACEMENT. 1800 I. H. P.
150x15½x4¼ ft.; speed 24 knots. Dubuque Iron Works.

economy in coal consumption,—a very vital question with boats of this class, and one that has too often been lost sight of.

A boat of a somewhat different character is the Sokol, built by Yarrow for the Russian government. She is 190 feet long, 18 feet 6 inches beam, 7 feet draught, and of 240 tons displacement. The average speed on the three-hour run was 29 knots, but, when forced to 4,490 h. p., she ran for a short time at 30.3 knots. Being fitted with eight



ARGENTINE TORPEDO-BOAT DESTROYER "SANTA FE." 4200 I. H. P.
190x19½ ft.; speed 26 knots; 1½ in. armor protecting engine and boiler space. Yarrow & Co.



RUSSIAN TORPEDO-BOAT DESTROYER "SOKOL," 240 TONS DISPLACEMENT. 4490 I. H. P.
190x18.6 ft.; maximum speed 30.3 knots. Yarrow & Co., Poplar.

water-tube boilers, instead of three as in the *Desperate*, she is obliged to have four smoke-stacks.

The *Furor* and *Terror*, built by J. & G. Thompson, of Glasgow, for the Spanish government, are 220 feet long, 22 feet beam, 5 feet 6 inches draught, and of 380 tons displacement. With 6,200 h. p. the speed was 29 knots per hour. The armament consists of two fourteen-pounder quick-firing guns, two six-pounder quick-firing guns, two 30 mil. auto. quick-firing guns, and two torpedo tubes. They carry a load of 75 tons, and are a good deal bigger and heavier than the English boats of this class.

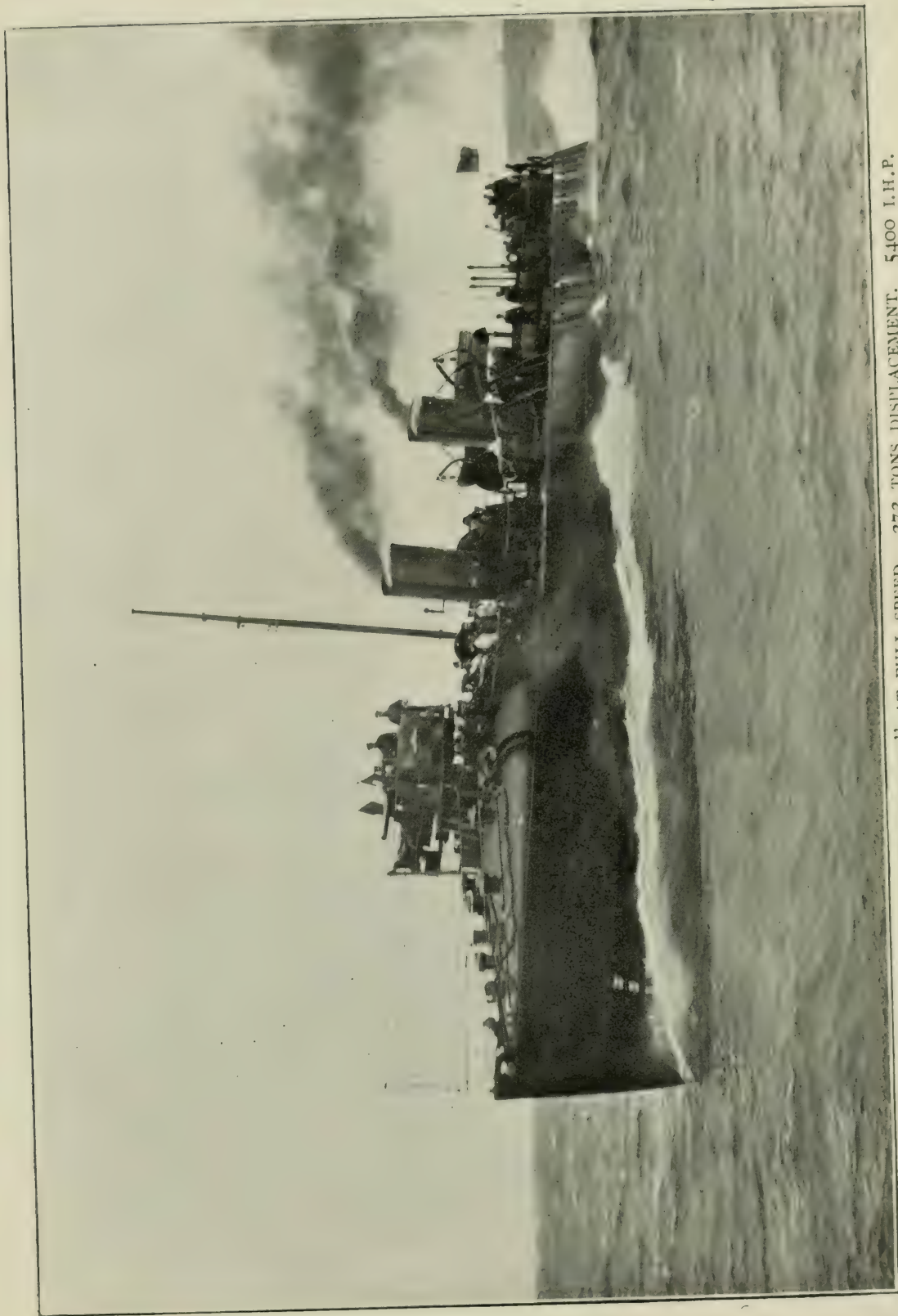
The *Audaz*, *Osado*, *Pluton*, and *Proserpina*, later boats by Thompson, built for Spain, are 225 feet long, 22 feet 6 inches beam,



H.M. TORPEDO-BOAT DESTROYER "SHARK." 280 TONS DISPLACEMENT. 4100 I.H.P.
200x19.5x5.2 ft.; speed 27.6 knots. J. & C. Thompson, Glasgow.

5 feet 9 inches draught, and of 400 tons displacement. On trial, with 7,500 h. p., they made a speed of 30.3 knots per hour. The armament is the same as that of the *Furor* and *Terror*, the coal capacity being 100 tons.

From the foregoing it will be seen that "destroyers" of the present class vary between 275 tons and 400 tons trial displacement, with an average speed of 30 knots on a three-hour run, and this with a coal-consumption of not more than 2½ pounds per i. h. p. As a matter of fact, on recent trials of boats of the smaller class, the speed of 30 knots has been attained on 2.06 pounds of coal per i. h. p. As the size of the boat increases above 300 tons, it is found that more power



H. M. TORPEDO-BOAT DESTROYER "FAME," AT FULL SPEED. 272 TONS DISPLACEMENT. 5400 I. H. P.
210x19.6x7.2 ft. Average speed on three hours' trial 30 knots. John I. Thornycroft & Co., Chiswick, London.

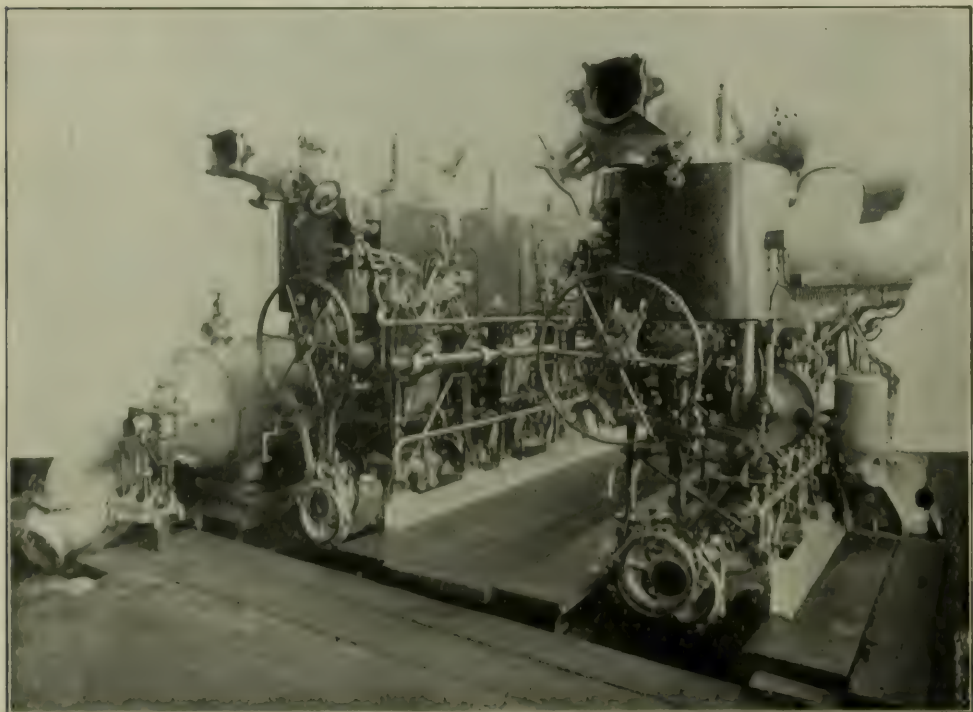


TORPEDO-BOAT DESTROYER "WHITING" STEAMING 31.3 KNOTS. 300 TONS DIS-
PLACEMENT. 5900 I.H.P.

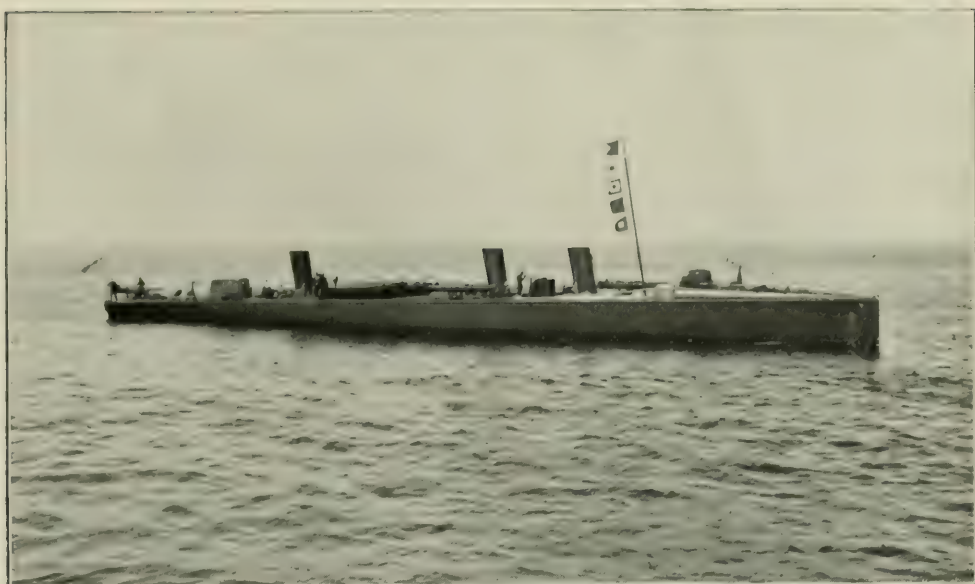
205x20 $\frac{2}{3}$ x6 $\frac{1}{2}$ ft. Built by Palmer's Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne.

in proportion is required for a given speed, and hence a greater coal-consumption. In this connection the following quotation from a paper read by Mr. Thornycroft some years ago is of peculiar interest :

"The very large power required for the torpedo-boat destroyers—of which the Daring may be taken as an example—to attain their



THE ENGINES OF A TORPEDO-BOAT DESTROYER.
Palmer's Shipbuilding Co., Jarrow.



U. S. TORPEDO BOAT DUPONT. 185 TONS DISPLACEMENT. 3500 I.H.P.
170x17x5.5 ft.; speed 28 knots. Herreshoff, Bristol, R. I.

speed indicates the enormous difficulties which bar the way to attain equal speeds in larger vessels, for, although there is economy of power to be obtained generally by increased size of vessel, this rule is subject to complete reversal under certain conditions, which can be explained by Froude's law of corresponding speeds, which show that, although we can attain a speed of 30 knots economically in a vessel of about the size of the present destroyers, if we increase the displacement three or four times the performance is far less satisfactory; and, if we go on increasing, we shall not arrive at a size favorable to this speed, until we get to the largest dimensions."

A leading article in London *Engineering* made the following remarks, which it will pay to keep in mind during the present crisis:

"This statement, taken in conjunction with a previous expression of opinion made by the author as to the limitations of efficiency in the screw propeller—limitations which appear to have been very closely approximated to in the destroyers—seems to show that a halting-place is in sight in regard to dimensions and speed of vessels of the torpedo class. The prospect is not unwelcome from many points of view. So long as it was sufficient to get a faster boat simply by the brute-force principle of bigger boats and bigger engines and boilers, the least well-informed builders, having the command of cheap labor and cheap materials, could always go one better than their less favorably situated competitors in regard to commercial considerations by adopting the designs of better-informed constructors and adding somewhat to the dimensions. This is notoriously the



CHILIAN DESTROYER "CAPITAN ORELLA." 300 TONS. 6000 I.H.P.
210x21½x5¼ ft.; speed 30.17 knots. Laird Bros.

method that has been followed in certain cases of late." And, it may be added, not always with success.

In this general connection the results of the official steam trials of the English "destroyers" during 1897 will be of interest. The best result obtained by the Laird boats of 300 tons trial displacement was a consumption of 2.41 pounds of coal per i. h. p. per hour. Of the five boats by Palmer, each of 300 tons trial displacement, the best result was 2.42 pounds per i. h. p. per hour. The later of the Thornycroft boats, of 275 tons trial displacement, were able to obtain a speed exceeding 30 knots on a coal-consumption of 2.06 pounds per i. h. p. per hour. Several factors may have combined to thus keep down the consumption, but the fact remains that the boats of the smaller displacement, which Mr. Thornycroft had in mind when he made this statement, were by far the most economical.

A trial trip last summer in the North sea, on a boat of the type of the *Desperate* with half a gale blowing, very clearly showed that a boat of this size, with plenty of free-board, is capable of running satisfactorily at the high rate of speed called for.

The "destroyers" built in the south of England, and on the Thames, run their trial trips off the Nore. The boat is taken out of the dock by the officers of the Royal navy. The machinery is all in the care of the builders, who are responsible for the run. They provide their own pilot, who takes charge of the steering when she is put

on the measured mile. If the boat has not been out before, she at once steams down to Sheerness, where she is swung for the adjusting of compasses. Directly this is done, the boat gets under way, and all becomes activity and life; orders are given for closing hatches and for starting the fans which produce the forced draught. From previous experiences it is known that it takes about half an hour to get everything in full swing, and in about that time the trial will begin. The boat has to run for three hours, and to be run over the measured mile six times, three with the tide, and three against it; the revolutions are taken from start to finish, and are taken regularly while on the mile; at this time indicator cards are also taken. After the first two runs the man in charge of the machinery is able to tell what rate of speed he is making, and, if he is not satisfied, he at once tries to turn his engines faster; before the last of the six runs, he will have been able to tell just what average of revolutions he must maintain to give him a speed a little in excess of the contract speed. It is now nearly always the case that, by the end of the runs on the mile, they find that the engines can be slowed down a little for the remainder of the trial and the necessary speed obtained.

It does not at all follow that this speed will be attained on the first trip. On some of the early "destroyers" from twelve to twenty attempts had to be made before all worked satisfactorily. Unfortunately, in a number of cases, the accidents to the machinery have been followed by serious results, and many are the poor fellows who have been badly scalded from the cracking of a cylinder or the breaking of a steam pipe. If this is the case in times of peace, when everything is favorable, how much more is it the case when running in the face of an enemy. Owing to the extreme liability of these boats to machinery trouble while running at high speed, each navy must possess a large number, so that, though a percentage of the boats should be disabled, the fleet may still be safe.

The British naval authorities have had so much experience with this class of work that they have found it wise to put the running of all torpedo boat and "destroyer" trials solely in the hands of the engineers and constructors of the navy. All that the line officers are called upon to do is to take charge of and navigate the boat. In England this is generally conceded to be their proper work. The admiralty does not allow them to have anything to do with the decision as to the acceptability of the boats from the contractors.

It is much to be regretted that it is impossible to give illustrations of any American "destroyers," and it is sincerely to be hoped that the present crisis will bring about a more consistently and continuously liberal policy in naval matters.

RAILROAD FARES AND PASSENGER TRAVEL.

By H. G. Prout.

IT has been suggested that I say something along the line of Mr. Stevens's article in the March issue of *THE ENGINEERING MAGAZINE* on British railway fares and their influence on traffic. I attack the subject with a little reluctance. Macaulay said of Dr. Nares: "He employs more words in expounding and defending a truism than any other writer would employ in supporting a paradox." It is so obvious that there is a close inverse relation between fares and the volume of travel that one takes a risk of calling down upon himself the same kind of criticism, if he undertakes to demonstrate that there is such relation. Mr. Stevens has escaped that kind of criticism by telling us little of this relation in Great Britain. He gives certain interesting figures about passenger travel and passenger rates, but nothing by which we can accurately, or even approximately, measure their growth or decline, mainly, we suppose, because neither he or anyone else can give such figures.

It is the old story of attempting to analyze British railroad statistics. You are confronted with the fact that no unit of movement, either passenger-mile or ton-mile, is given. You can only guess what that movement has been. Mr. Stevens's nine-mile average passenger journey is a guess. You may say that at least you have the number of passenger journeys, and can compare them from year to year; but, in fact, you have no comparable figures. All the statistics of passenger journeys in Great Britain are given "exclusive of season and periodical tickets." I once tried to estimate the total number of passenger journeys in Great Britain. (I was never so rash as to try to estimate the passenger-miles, for I would not even guess at the average journey.) I found that 864,500,000 passengers were carried in the United Kingdom in one year (1892) exclusive of season and periodical passengers, of whom there were 1,612,510. I guessed that each of these latter made 300 trips a year,—apparently a moderate estimate,—and that therefore the whole number of season and periodical journeys was 480,000,000. So I got at a total of 1,344,500,000 passenger journeys made in the United Kingdom in one year. Mr. Acworth pointed out that I had deliberately and voluntarily gone out of my way to make a blunder by not first ascertaining that these season tickets are so often for a week or two, and not for a year, that any estimate of the total journeys is misleading.

Further, we can get at the average passenger fare or freight rate

by guessing at our premises and expanding them. Some years ago a distinguished member of the American Society of Civil Engineers wrote a famous book on this plan. He guessed at certain fundamental facts, and then, on the basis of these facts, he proceeded to compare English and American railroads through one hundred and forty pages of type, with many tables and diagrams, to the immense interest and instruction of the half-informed. I have not seen that book quoted for at least five years.

The best comparative figures that we can get at are these: The average passenger fare in the United States in 1896 was, according to Poor, 2.034 cents a mile; according to the interstate commerce commission, 2.019 cents. The average in England was estimated by Mr. Acworth, after careful analysis, at between 1.3 and 1.4 cent; "that it cannot be higher than 1.6 cent I feel absolutely sure."

But Mr. Stevens does tell us many things about the course and condition of British passenger traffic that are worth while; for example, about reduced-rate tickets for workingmen and for excursions, and about the growth of third-class travel, all of which it is well to state for the benefit of the rising generations of general passenger agents, traffic managers, and other readers.

Before leaving Mr. Stevens, it may be well to remind him and the reader that we do have in the United States two well-marked classes of passenger accommodations and passenger rates, in constant and great use, and that the British writer is constantly making mistakes by ignoring this fact. The day-coach travel and the parlor-car and sleeping-car travel make two classes just as distinct and as characteristic as the first-class and third-class travel in England. Whether or not the passenger goes by one or the other of these classes is a mere matter of the money paid, exactly as it is in England. There a peer may (and, in fact, often does) go third class, while the man who wants to seem to be a peer will probably go first class. Really, it is mostly a matter of comfort, there as here. You buy the amount of comfort that you care to pay for; and for 500 miles it is hard to beat the comfort of an English first-class compartment, especially if you care to invest a shilling on the guard and secure a coupé to yourself.

It may be well also to glance at the seclusion notion, which is again brought up by Mr. Stevens. The notion that in a British compartment you have more seclusion than in the American open car is one of those cherished delusions of the Briton, much like, for example, the notion that we do not have cheap cabs in the United States because we cannot drive well enough, or like the delusion of some of the correspondents of one of the great English engineering journals that we make wonderful locomotive records in America be-

cause the miles are short. You can have seclusion in Great Britain if your party fills the compartment, or if you tip the guard, but it is hard to find more disagreeable publicity in traveling than sitting in a compartment facing and jolting against the casual stranger who straggles in, be he Englishman or traveling American.

We cannot hope to discover the relations between passenger fares and passenger travel even in the United States, but we can at least know what the fares and what the movements have been at various periods, and so try to discover the relation between them.

From 1886 to 1896 the average passenger rate fell $7\frac{1}{2}$ per cent. and the passenger movement increased 35 per cent., but it would be assuming a good deal to say that one was the cause of the other. In fact, the population of the United States gained 24 per cent. in the same time, and an important part of the increase in passenger travel must be attributed to that. It is a common experience that passenger movement in cities gains faster than the population, owing to the increase of facilities for movement; but from 1886 to 1896 passenger travel per mile of railroad worked actually decreased 7 per cent. The travel did not gain as fast as the opportunities to travel, in spite of lower fares and of greater population.

Perhaps it is not quite fair to take the whole territory of the United States. Let us take, then, some part of the country where conditions are perhaps closer to the normal. For example, in Massachusetts, the passenger miles per mile of railroad worked amounted to 297,500 in 1886, and in 1896 they had risen to 375,000,—a gain of 26 per cent. This is a fair measure of the relative use of the railroads by travellers; it had increased about 26 per cent., while in the whole United States it decreased 7 per cent. In the same time the population of Massachusetts gained about 28 per cent., and the average fare fell 5 per cent.

We see the impossibility of establishing any general relation between rates of fare and passenger travel, and it is just about as difficult to find special cases that prove much. In the nature of things a standard steam railroad very seldom makes any considerable reduction of fare for regular service extending over some time and not complicated with other conditions. Of course, we are all familiar with cases of a heavy passenger movement stimulated by low excursion rates; but, where this has lasted for some weeks, or months, it must have been because there was some object in going on the excursion other than to take advantage of a low rate.

The elevated railroads of New York give us a pretty simple case of rates and movement. In December, 1880, the commission hours (the hours during which 5-cent fare was charged) were increased two

hours a day, making the total six hours instead of four. The result in the average receipt per passenger carried was a decline from 7.59 cents to 7.02. The increase in the number of passengers carried during the next year was 24.3 per cent.; the year following, the fares remaining stationary, the number increased 14.2 per cent.; the next year 6.6; and after that there was no considerable increase in passengers carried until 1886 and 1887. Such increase as took place was perhaps due mostly to growth of population. But at various dates in the last half of 1886 the rate was reduced to five cents for all hours of the day on all lines of the system. The passenger movement increased from 108.7 millions a year to 159.6 millions, or almost 47 per cent. The effect on the revenues we need not consider here. This is a case where obviously the movement of passengers was greatly stimulated by reduced fare.

But the case was very peculiar. In some ways it could not be duplicated anywhere else in the world,—not in London, or Chicago, or Paris, or Berlin. The fares were cut in two, there was a vast population to serve, the existing modes of travel were wretched,—we have all forgotten how slow and infrequent and crowded and dirty the old horse-cars were,—and, finally, the shape of the city made it possible to concentrate much of the travel on the lines of the elevated. Such a set of conditions on such a scale could not be found elsewhere, and probably never will be found again.

Another important example in city travel has lately occurred in New York in the conversion of the Fourth avenue horse-car line into an electric line. The change was immediately followed by a great increase in passenger movement, although there was no reduction of fare. In February, 1897, the passengers carried by horse cars on the whole Fourth avenue division were 1,473,713; in February, 1898, with electric service down only to Astor place, the passengers carried on this division were 2,931,538. The movement had doubled, but the fare was the same. This example shows us how dangerous it is to reason from part of the facts.

But to return to railroads proper. Most of us have opportunities to observe the effect of cheap rates on the human mind. We constantly see our friends set a-going by the mere fact that they can get a cheap return ticket, on account of some convention excursion or the like. We are all familiar with the remarkable effect of a cheap family-ticket or 50-trip ticket on the minds of the ladies of our families. They will go to town once, if they must pay 50 cents for the return ticket, but three or four times, if they have a special return ticket reducing the fare to 34 cents. The male accountant is sometimes tempted to doubt the benefit to the community of these special rates,

but the benefit to the railroads is unquestionable. Trains are filled, or, at least, made to earn something at hours when they would otherwise run practically empty.

It is apparent to any man of observation and experience that the copious issue of commutation tickets at three-quarters of a cent a mile and 50-trip family tickets at $1\frac{1}{3}$ cents a mile has a great effect in stimulating travel in the vicinity of a city. It gets people to move, and, further, it builds up the country with a population having an inclination to stir about and the means to gratify that inclination. But, further than this, we cannot say that in the United States special cheap fares have done much to set the masses moving. We may leave out of consideration long-distance special-convention excursions and the like. These are merely incidental and sporadic, and cannot be counted on as part of a regular and permanent traffic.

It has long seemed to many observers that the railroads might do a good deal more than they do now to create travel by special rates. Obviously, the true principle in this is to offer attractions that will induce folks to go somewhere when they would otherwise stay at home. The English do this on a scale and in a variety of ways that have never been approached in the United States. I need not repeat here the list of special-rate tickets that Mr. Stevens gave in the March issue of *THE ENGINEERING MAGAZINE*. It is enough to say that people are inclined to go to the seashore, to the lakes, to the highlands, to the cathedral towns, to town for the theatre, and to the country for golf, by tickets as cheap as one-half or three quarters of a cent a mile,—rates which are approached in the United States only by the regular commutation tickets.

But, when all is said, it is useless to lay down any general proposition,—such as, for example, that, if you reduce fares, you will increase travel. Perhaps you will, and perhaps you will not. One of the clearest-headed transportation men of my acquaintance, a very successful manager of city railroads, who is often called in to advise, lately said to me: “I warn my clients that they cannot be guided by my experience, except in generalities; every case is different.” Most of us, as we grow older, acquire more distrust of general solutions, by theory, of such questions as that of getting and handling traffic. Voltaire said: “All general statements are false, and probably this one is also.” We learn to try to discriminate among our facts. In Texas, for example, the passenger miles per mile of railroad are about 33,000; in Massachusetts they are 375,000. If we carried people of Texas free, we could not get any such movement as the people of Massachusetts pay for, because the population per square mile in Texas is 10, while in Massachusetts it is 300. Again,

to the people of some regions two and one-half cents is a considerably larger sum of money than is five cents to the people of other regions. Although Belgium has 1.88 times as many inhabitants per square mile as Massachusetts, it may be that there are more people per square mile in Massachusetts who would spend 50 cents to travel a given distance than there are in Belgium who would spend 25 cents for the same journey. All of this means that there are a great many things which enter into building up passenger travel, besides low fares.

Again, if we carried passengers as cheaply as they are carried in Belgium or in India, it is not likely that we could provoke so great a passenger movement per mile of railroad, even in Massachusetts; and this for at least two reasons.

The greater wealth of American and English people permits them to pay more for railroad travel, and their time is worth more to them than the time of a poorer people. Therefore, a reduction in fares would not be so important to them as to a poorer people, and would not so much affect their movement, because they can afford to spend more money to travel, and they cannot afford to spend so much time. At least, this is a plausible theory.

The second reason is that there are actually fewer people to draw upon; and this brings us to some very remarkable facts. Let us take, for instance, the case of Belgium. The population there is 564 persons per square mile, while in the whole United States it is only about 24, and in Massachusetts it is 300. The railroads there number 5.4 miles for each 10,000 inhabitants, the same figure being 26.6 in the United States. The average passenger fare there is as low as 0.95 cent per passenger-mile. The average in the United States is 2.019. The result is that, with an average passenger train load of 70 passengers, the yield from passenger business on Belgian roads is only 71 cents per train-mile. In the United States, with a train load of 39 persons, the train-mile earnings amount to 98.59 cents. We see that it is a matter of very serious question whether or not fares as low as those of Belgium, would create as great a passenger movement in a country of sparser population; it is almost certain that it would not create a passenger movement which would pay the railroads. They would lose money on passengers, and would have to make it up in freight, or else cease to run. But it is probably a safe proposition that it is immensely more important to a nation to have cheap freight rates than to have cheap passenger rates. In Belgium, for instance, the earnings per freight train mile amount to \$1.74 with an average train load of 136 tons, from which we deduce an average ton-mile rate, for freight, of 1.27 cents; but in the United States the average freight rate has fallen to 0.806 cents.

But we find in India figures even more remarkable than those of Belgium. We find there much the lowest passenger rate in the world, —namely, 0.338 cent. This is taking the gold value of the rupee at 26 cents, which was its average value in the year for which this passenger rate was deduced. This rate is only $\frac{6}{10}$ of the average passenger rate in the United States, and a still lower average rate would be found on the great Indian lines situated in the region of densest population.

But in that country even this wonderfully low rate is perhaps profitable, for the average train load was 150 persons in the year in which it was 38 persons in the United States, and it is possible to do business at such rates if you can get heavy loads, move them at infrequent intervals, move them slowly, and carry the mass of the passengers in bare cars, seated on benches. But, of course, such a traffic could be created only in a region of dense population. The greatest development of the Indian railroads is in regions having more than 500 people per square mile, while great regions of India have more than 800 people per square mile. Given such conditions, a country populated like an ant-hill, with people accustomed to low wages and habituated to indefinite leisure, it becomes not only possible, but necessary, to sacrifice speed and frequency, and luxury, and even comfort, to low fares, and to reduce the fares to rates unheard of in America.

From these somewhat scattering remarks we may perhaps draw the following conclusions. Reducing fares will increase movement, and so will the provision of some attractions at the end of the journey ; but the density of population and the wealth of the people come in to modify the matter in a subtle and ever-changing way. Thus the best policy of any given railroad in any given case must be a matter of judgment, based on careful experiment and much observation. It is a repetition of the old story that the judgment of a wise man must always be superior to theories based on general facts.

THE ECONOMICAL USE OF STEAM IN NON-CONDENSING ENGINES.

By James B. Stanwood.

IN America the non-condensing engine is almost universally employed, especially in those districts where fuel is cheap and condensing water is dear. These conditions obtain over a very large portion of the country, particularly in cities and towns. Any improvement, therefore, in the economy of non-condensing engines benefits a large majority of American steam users.

Not very long ago, but before the days of Mr. Corliss, steam pressures of 40 to 60 pounds were in vogue. Plain slide valves cutting off at about three-quarter stroke, or adjustable cut-offs by means of which more expansion was obtained, were generally employed. The speed of the engine was controlled by a butterfly valve operated by a fly-ball governor. The small mean effective pressure, in conjunction with a high pressure of steam at the end of each stroke of the piston (the terminal pressure) caused by a reduction of initial pressure and a low grade of expansion, was absurdly uneconomical. Mr. Corliss, by the invention of the automatic cut-off, radically changed these methods of steam distribution. Steam was admitted to the cylinder with as low initial pressure as 60 pounds, and, with nearly uniform loads, the size of the engine was proportioned so that the cut-off occurred at about one-quarter stroke, and the pressure at the end of the piston stroke was slightly in excess of atmospheric pressure. Under these conditions a maximum mean effective pressure was obtained with a low terminal. This satisfied the conditions existing in factories at that time,—a probable dead load of nearly 50 per cent.

Observe what would have been the result, if these engines had been required to operate for long intervals with one-third or one-quarter load; the cut-off would have been automatically adjusted to one-eighth or one-tenth of the stroke, and with 60 pounds of steam the degree of expansion would have been so great that the terminal pressure at the end of the piston stroke would have been 5 or 6 pounds below atmospheric pressure, reversing the pressure on the piston and causing it to drag like a pump. At the same time the mean effective pressure would have been as low as 8 or 10 pounds—far too small for economical operation.

This high degree of expansion sometimes occurred in Mr. Corliss's practice, especially where engines too large for the work required

were installed ; builder and user were sorely disappointed at the resultant waste, and were at a loss to account for it. It was easily seen that the drag of the piston, due to expansion below the atmosphere at the end of the stroke, accounted for part of it. But should not this have been offset by the high degree of expansion ?

With recent developments in electricity a steam engine driving a generator is the ordinary instrument for deriving energy from coal. In this application light loads and variable loads form a greater proportion of the engine's duty than formerly. For instance, in most factories with mechanical transmission a large portion of the power given out by the engine has gone to drive the transmission machinery,—that is, gearing, shafting, pulleys, and belts. This dead load frequently consumes one-third to two-thirds of the entire power. An engine in such a factory always has a large minimum load. When electrical transmission is employed, the transmission load appears only when work is being done at the motor or lamp, so that the minimum load on the engine is only that due to its own friction together with the resistance of the generator,—usually, in all, not more than 20 per cent. of the rated capacity of the engine. It is seen, therefore, that with electrical transmission the fluctuations in load between maximum and minimum are much greater than with mechanical transmission. On account of a high degree of expansion developed by this prevalence of light loads in this field, it has not been possible to operate engines economically.

Experience has shown that there is a limit to the degree of economical expansion, and this limit has been found to vary with different types of engines. Long-stroke engines were found to have a greater limit, and to be more economical, than short-stroke engines ; short-stroke engines at high speed were more economical than short-stroke engines at slow speed ; engines with small clearance spaces (the waste space between the piston head and cylinder head at end of stroke, including the steam ports) were more economical than those with large clearance spaces. In long-stroke engines the most economical degree of expansion was found to be about four ; in some short-stroke engines it was as low as two. That is to say, in long-stroke engines the economical cut-off should take effect not earlier than one-fifth of the stroke, and in some short-stroke engines not earlier than one-third. Experimental investigations have shown the reasons for this limitation of expansion ; practice and experience have devised methods of extending the limit.

Two serious losses develop with high expansion produced by early cut-offs in single-cylinder engines. The first and most easily discerned is known as the "clearance loss" ; the second and more sub-

tle is the "cylinder condensation loss." It is obvious that, if the clearance spaces have to be filled at each stroke with fresh steam from the boiler, there is a distinct loss, since this steam is thrown away without doing much work. Clearance space in long-stroke engines is ordinarily 3 or 4 per cent., though it has been reduced to about 1 per cent. in special cases. In some short-stroke engines the clearance is 15 or 16 per cent. This accounts for one advantage of long-stroke over short-stroke engines. Wherever clearance spaces are large, they can be partially filled by compressing into them some of the steam left in the cylinder during exhaust; but, as a rule, they give poor economy, as this gain by compression is only slight.

The "cylinder condensation loss," the largest of all the losses, is not generally understood by steam users themselves, although clearly recognized by intelligent engine builders and engineers. The laws which govern it have not been fully ascertained quantitatively, although the manner in which they vary is fairly well understood.

What is this loss?

At each stroke that any engine makes, fresh steam from the boiler meets the surfaces of the steam passages, cylinder head, and piston head, and the cylindrical walls of the cylinder up to cut-off, all of which have previously been cooled by exposure to the low temperature of exhaust steam, and by the abstraction of heat during the period of expansion. These cool surfaces have to be reheated by fresh boiler steam, in order that the cylinder may be habitable for that portion which is to do work. A certain part of this fresh steam is thereby condensed, and becomes a loss, which is called the "cylinder condensation loss."

This amount of cylinder condensation seems to depend upon the amount of condensing surface exposed up to the point that cut-off takes place; upon the difference in temperature between fresh incoming steam and out-going exhaust steam (known as the range of temperature); upon the time which these surfaces have for cooling and reheating (this is regulated by the speed of the engine); and upon the degree of expansion which takes place in the cylinder. The nature of the surfaces, whether smooth or rough, likewise has influence on the amount of condensation. It is difficult in any engine to forecast exactly the amount of cylinder condensation, but in any given engine it appears to be nearly constant at all points of cut-off at any given speed, boiler pressure, and exhaust pressure.

Under these conditions the "cylinder condensation loss" acts very much like a large clearance loss. It is least in long-stroke engines, as they offer less surface for condensation, per volume of steam used; it is most in short-stroke engines, for the opposite reason.

High-speed short-stroke engines are an improvement upon slower short-stroke engines, as the time for condensation is less. In an ordinary long-stroke Corliss engine, working with either early or late cut-off, about $7\frac{1}{2}$ per cent. of a volume of steam equal to the cylinder-full at boiler pressure is condensed to keep the cylinder hot.

If 2 per cent. of the steam is thrown away as a clearance loss and $7\frac{1}{2}$ per cent. as a cylinder condensation loss, the total loss is $9\frac{1}{2}$ per cent. This loss is relatively much larger when steam is admitted for only one-sixth or one-fourth stroke than when it follows the piston for one-third or two-thirds stroke. Therefore the losses, together with the drag of piston on account of expansion below the atmosphere, are much greater with early cut-offs than with late, and the economical limit to expansion is reached when the gain due to expansion is neutralized by this increasing loss of clearance and cylinder condensation and "drag." It is thus easily seen that large engines with light loads, or engines which work under great variation of loads, must operate at early cutoff, and under three very disadvantageous conditions,—to wit, with heavy clearance loss, with cylinder condensation losses, and with a positive resistance developed in the cylinder by the dragging of the piston against atmospheric pressure.

Since the days of Mr. Corliss, steam pressures have continued to increase; this increase of pressure has intensified, in single-cylinder engines, clearance and cylinder-condensation losses. The absolute clearance loss is increased, because the clearance spaces have to be filled by steam at higher pressure, which weighs more per cubic foot than steam at lower pressure. The absolute cylinder condensation loss is increased, because the difference in temperature between fresh incoming steam and outgoing exhaust steam (range of temperature) is increased. For example, the temperature of steam at 60 pounds pressure is 307° F., while the temperature of steam at atmospheric pressure, at which it exhausts, is 212° F.,—a difference of 95° F. The temperature of steam at 100 pounds pressure is 338° F., making a difference of 126° F.; and this increase of temperature-range condenses a greater amount of fresh boiler steam (which is another way of stating that cylinder condensation is increased).

The increase of pressure, however, has reduced the loss due to the dragging of the piston against atmospheric pressure in single-cylinder engines. With a given maximum cut-off, the ratio between the minimum mean effective pressure (that can be secured without expansion below the atmosphere) and the maximum mean effective pressure becomes greater, so that a lighter load in proportion to maximum load can be carried than with lower boiler pressure.

The clearance and condensation losses tend to prevent a gain in

economy with high-pressure steam. To secure this gain, which was theoretically possible, engineers were compelled to abandon the plan of using steam in one cylinder only, experience having proved that higher degrees of expansion with less loss can be secured by expansion through two or more cylinders. A knowledge of these facts was obtained by experience in marine practice, where many practical advantages were secured, besides economy of fuel by the use of multi-cylinder expansion engines.

The success in this field of engineering naturally attracted the attention of steam users and builders of stationary engines. Manufacturers of automatic cut-off engines began to compound their engines. When condensers were employed with these newly-arranged engines, a very satisfactory saving was effected, but, when these engines were built for non-condensing service, the result was a positive failure, except in a few rare instances, where the load was nearly constant and the engine properly proportioned and designed for that load.

Unless the amount of power required is so great, and the change in the load so gradual, that a number of units can always be kept in service with nearly a full load upon each unit, the compound-non-condensing automatic cut-off engine is ill-adapted for electrical plants in which there is a great variation between light and full load.

The conditions that have caused the failure of this type of engine under varying loads are the same that have caused the failure of single-cylinder automatic-cut-off engines similarly loaded. Before considering them, it is well to state the different methods of distributing steam in these compound engines. There are two distinct methods of distribution: first, where the valve or valves of the high-pressure cylinder are under control of the governor; second, where the valve or valves of both cylinders are under control of the governor. Another dual classification can be made by grouping those engines in which the admission valves are under control of the governor, and those in which both admission and exhaust valves are under this control.

With light loads, the loss due to expansion below the atmosphere is greater than in simple engines, as this loss develops in the low-pressure cylinder, which has a large area and gives a great resistance. Frequently the low-pressure cylinder is converted into a pump, which has to be dragged along by the high-pressure cylinder. As boiler pressures increase, this difficulty is not lessened, because the minimum mean effective pressure that can be obtained without expansion below the atmospheric line increases with the boiler pressure, and at about the same rate as the maximum mean effective pressure, so that the ratio of minimum to maximum mean effective pressure is not reduced for light and heavy loads, as is the case in simple engines. In engines

in which valves of both cylinders are under control of the governor, this drag develops in the high-pressure cylinder whenever its terminal pressure falls below the high receiver pressure induced by early cut-off on the low-pressure cylinder.

When the governor controls both the steam and exhaust valves on both cylinders, and the load is light, it is necessary to employ enormously large clearance spaces, into which the steam imprisoned by early compression can be compressed without overstraining the engine. The effect of these large clearance spaces is to maintain a very high terminal pressure in each cylinder, which, with light loads, greatly reduces the chance for the "drag," but, with heavy loads, greatly increases the loss from clearance. In fact, these engines operate with only moderate degrees of expansion, considering the neutralizing effect of their large clearance.

By proper treatment of compression, clearance losses can be greatly reduced in compound engines. This is the case in engines in which the governor controls only the admission valves of both cylinders. By proper adjustment of these valves the receiver pressure can be kept nearly constant; with small clearance spaces and a fixed compression, the clearance losses can be kept very small, and become excessive only with very early cut-offs. But, in an engine in which the governor controls the valves of the high-pressure cylinder only, this loss is greatly augmented at light loads, because the high degree of expansion caused by an early cut-off gives a low receiver pressure, and the clearance spaces have to be filled at every stroke with a low back pressure by steam at boiler pressure.

The chief economical advantage of compounding is to reduce the cylinder condensation loss. We have already seen that the difference in temperature between 100 pounds steam pressure and atmospheric pressure is 126° F. This difference amounts to 154° for 150 pounds pressure, and 169° for 200 pounds pressure. By expanding steam through two or more cylinders, this temperature range can be reduced to $\frac{1}{2}$, $\frac{1}{3}$, etc., according to the number of cylinders used, provided, however, that the expansion is properly divided in each cylinder. By reducing this temperature range a great reduction can be effected in the cylinder condensation loss.

We have seen that cylinder condensation in a simple engine is proportionately less at a late cut-off than at an early cut-off. This holds true in compound engines; but, whereas, in the simple engine, the late cut-off is uneconomical on account of the low degree of expansion, it becomes economical in the compound engine, as a high degree of expansion is obtained, and at the same time it is unhampered by excessive cylinder condensation.

Under these considerations it can be seen that, in an engine in which the steam distribution is controlled by varying the cut-off, and in which light loads are developed by means of early cut-off, it must follow that these early cut-offs induce increase of cylinder condensation losses (and clearance losses), and in that way completely neutralize the object of the compounding.

These are the reasons which render compound non-condensing automatic cut-off engines a failure for variable loads. They can be successfully employed, as we have stated before, only when the load is uniform and the engine properly proportioned for that load.

The mistake of engineers and designers is in assuming that the average automatic expansion gears upon which they have bestowed so much care and attention are suitable for the proper distribution of steam in a non-condensing compound engine. Some of these gears may possess superior advantages for regulation and high speeds, but their advocacy stands in the way of economy and intelligent development of the steam engine. With their use higher pressures cannot be employed, and they are unsuitable for the more moderate pressures now in vogue.

From the foregoing it appears that automatic expansion gears applied to non-condensing compound engines are inadequate for the proper distribution of steam for varying loads. Mr. Charles T. Porter, the celebrated American engineer, in a paper presented to the American Society of Mechanical Engineers in 1894, said: "It is clear that, if the variable cut-off had not been already in common use, nothing so unsuitable would have been devised for this purpose." He also said: "It has appeared to me that an opening presented itself for a large improvement in the direction of economy, by employing a fixed point of cut-off, suitably selected, and regulating by means of a throttling governor."

The writer believes that, where the load is variable, the employment of a throttling governor with a fixed point of cut-off as a method of distributing steam in non-condensing multi-cylinder engines will lead to a satisfactory solution of this rather intricate problem.

In another paper the advantages and disadvantages of such a system of distribution will be set forth. Here it is necessary to state only that this system has been extensively developed in connection with vertical engines in England, directly connected to bi-polar electric generators, and operated at speeds as great as 400 or 500 revolutions per minute. The success of the system is largely due to the efforts of the late Mr. Willans, who was led, after years of experimenting, to select the throttle as an instrument by which to control the well-known high-speed engine bearing his name.

EUROPEAN SEA-GOING DREDGES AND DEEP-WATER DREDGING.

By E. L. Corthell.

II.—CONDITIONS JUSTIFYING DREDGING, AND THE RESULTANT COMMERCIAL BENEFITS.

THE exhibition of types of dredges and the analysis of the costs of dredging, which formed the basis of the article in the April number of THE ENGINEERING MAGAZINE, established the position that the apparatus is now so efficient and the expense so low that dredging is a reasonable resort for channel and harbor deepening and maintenance. It remains to consider the physical, economical, and commercial conditions which must be recognized as essential factors in the problem.

The situations where dredging is generally successful are: (a) At mouths of rivers with a strong fluvial flow confined by jetties. One of the most notable instances is the mouth of the Mississippi, where for twenty years a deep channel has been maintained by jetties, with occasional resort to dredging to preserve the required channel section, and where, in the formation of the channel, dredging hastened the enlargement.

At the mouth of the Brazos river, Texas, where at times there is a strong river flow succeeded by long periods of low water and with small tidal rise, the silt thrown out by the river floods into the sea tends to form a temporary obstruction there, requiring sometimes weeks for its removal by the action of sea waves and currents. The navigable depth constantly maintainable with complete and consolidated works is about twenty feet. If a suitable dredger were at hand to assist when required, a greater depth could be maintained, and there would certainly never be less than twenty feet under any possible conditions.

The Panuco river at Tampico, Mexico, is subject to great floods at long intervals, due to great rainfalls alternating with absence of rain for months and possibly years. The jetties at the mouth of the river maintain a deep channel, but a suitable dredger, like the "Octopus," would maintain a deeper one. The deposits made in the sea in times of flood would speedily be removed; any tendency to shoal in the jetty channel during the long intervals of low water would quickly be overcome.

A valuable lesson for such conditions as those at the Brazos and Tampico may be learned from the very satisfactory work done by the



COMBINED BUCKET AND SAND-PUMP HOPPER DREDGE "PERCY SANDERSON."
 220x14x17 ft.; hopper capacity, 25,180 cu. ft.; lifting capacity per hour, in free soil, pump,
 10,750 cu. ft., buckets, 20,900 cu. ft.; maximum depth dredged, 35 ft.
 Built by Wm. Simons & Co, Ltd., Renfrew.

Percy Sanderson, a combined bucket and sand pump hopper dredger (see photograph), at the Sulina jetties at the mouth of the Danube. About $20\frac{1}{2}$ feet had been maintained there by the works alone for many years, without any resort to dredging; but, as the success of the works and the maintenance of this channel were bringing larger and larger vessels to the harbor, it became desirable to deepen the entrance channel to the navigable depth of 24 feet. The Percy Sanderson was designed and built for the purpose, under the direction of Sir Charles A. Hartley, engineer of the Danube commission. This dredger moves about 300,000 cubic yards per annum from the jetty channel and the sea approach, and maintains the desired navigable depth of 24 feet, with generally a sounded depth of 26 feet. The entire cost of securing this great commercial advantage is not more than £8,000 per annum. The works have not been extended.

The value of even a few extra reliable inches of water for vessels is often so great that all works designed for the mouths of sedimentary rivers like those above referred to should contemplate, for the construction and maintenance of the channel-way, a first-class powerful dredger suited to the material to be dealt with.

(b) Openings into bays and estuaries which have a good tidal rise and flow. Where this tidal flow is confined to the entrance channel, as at Dublin and Tynemouth, occasional dredging will ensure the maintenance of a deep channel; and it is often the case that it can be

almost entirely dispensed with, to be called into use only when storms and a run of heavy sea for some days have thrown sands into the mouths of the jetties or breakwaters.

(c) Where works cannot be built, except at enormous expense, the sea bars being so far from the land that a contraction of the tidal flow cannot be made by any constructions. If a channel can be marked out that will be parallel to the tidal flow, particularly the ebb, a dredged channel can be made and maintained.

The most striking example of such conditions is at Liverpool. The sea bar of the Mersey estuary is eleven miles from the land. For



TWIN-SCREW HOPPER DREDGE "ST. MARTIN."

188x38x15½ ft.; hopper capacity, 700 tons; maximum dredging depth, 45 ft.; speed 9 knots. Built for the British Admiralty by Lobnitz & Co., Renfrew, 1894.

many years it was thought to be necessary to reach it in some way by works, but no plan could be devised that would justify the great expenditure required. There was a depth of only 10 feet over this bar at low tide. The competition with other ports, like Southampton, capable of much greater depths, threatened the commercial supremacy of Liverpool. The advance in perfecting and enlarging dredging appliances, and the success in the Gedney's channel, New York harbor, where 30 feet was secured without works by hydraulic dredging, and the necessity of making at Liverpool an equal depth for the steamships that entered New York harbor, compelled the construction of a great dredger that would meet the extraordinary conditions. This dredger and its companion have been described above. With some

smaller dredgers at first used, they have made a channel 1,500 feet wide and more than 26 feet deep at low tide and 57 feet deep at high tide. The channel was carefully laid parallel with the ebb-tide flow, which varies from $2\frac{1}{2}$ to 3 miles per hour. There flows into and out of the Mersey estuary, twice each day, an average volume of 500,000,000 cubic yards of water,—a quantity of moving water beyond the power of the mind to conceive; yet this was made to preserve a depth of 10 to 11 feet on this bar eleven miles out to sea.

Another case of similar conditions, so far as impracticability of works is concerned, is at Gedney's channel, leading into New York



STERN VIEW OF THE "ST. MARTIN." THE "ST. DUNSTAN" IS EXACTLY SIMILAR.

harbor from the sea. This was deepened by hydraulic dredging (sand pumps) to 30 feet depth at mean low water.

(*d*) Where there are no tides and no fluvial flow, but where jetties built into the sea protect a dredged channel from the encroaching sands.

A good illustration of these conditions is the Baltic sea and Zuider zee, at the entrance channels of Lubec, Rostock, Stettin, Danzig, and other ports of Germany and Russia, and at Swolchediep and Keteldiep on the Zuider zee. The only current force of any use is that produced by the winds; yet for many years channels of considerable depth have been maintained mainly by dredging.

There are conditions on the gulf of Mexico nearly similar to these, where there is a very small tidal range and very insignificant fluvial



BARGE-LOADING BUCKET-DREDGE "LYSTER."

190x35½x13 ft. ; lifting capacity per hour, in free soil, 15,900 cu. ft. ; Wm. Simons & Co., Ltd., Renfrew, Scotland.

discharge. I refer to Galveston, Aransas Pass, Sabine Pass, and some other less important harbors. At Galveston and Sabine Pass the jetties built into the sea have been supplemented by dredging to great advantage. At the former place the jetties are placed about 1½ miles apart, so that, except under certain abnormal and unusual conditions produced mainly by the winds and storm tides, there is practically no concentration by the tidal flow, and consequently very little force for channel development. The government has set two powerful, especially-constructed suction dredgers at work with efficient results. At Sabine Pass the jetty channel, also wide and with practically no fluvial discharge except at long intervals, has also required dredging to supplement the feeble effects of the works. At Aransas Pass, no doubt, with suitable works, economical dredging by a suction dredger would make and maintain a navigable 26-foot channel. It is proper, in this connection, to state that dynamite dredging has been attempted on this bar, with incomplete works, with some measure of success. And, at Brunswick, Ga., on the South Atlantic coast, where the conditions come under the head of "c", like those at Liverpool and New York, very successful work has been done by this method, with practically no assistance from dredging proper, the only dredging work consisting of smoothing over by rakes and drags the irregular bottom left by large charges of dynamite, which shook up the entire bar and loosened the materials composing it, so that the strong

tidal flow gradually carried them to deeper water outside, where they were dispersed north and south by the currents of the sea and the action of the waves. This interesting and really important engineering work the writer hopes to describe and illustrate at an early date.

(*c*) At the entrances of artificial channels where a great commerce justifies extraordinary expenses.

Ymuiden and Hook of Holland, already referred to, are cases in point. The large tonnage of Amsterdam and Rotterdam makes the annual dredging of more than half a million cubic yards justifiable, when it would be utterly ruinous to smaller ports.

The entrances of Calais, Dunkirk, Ostend, and, in fact, nearly all the North sea ports of France and Belgium, except Antwerp, require constant dredging to maintain the navigation. Winds, waves, and currents are constantly washing the sands into the harbor entrances. The most approved method is to excavate in calm weather a sand reservoir outside the sea ends of the jetties on the side from which the sands mostly come, so that in storms the sands may tumble into this hole, instead of into the entrance channel, blocking navigation. When the storms subside, the excavation is again made. All of these



SAND-PUMP HOPPER DREDGE "KATE."

200x39x14½ ft.; hopper capacity, 20,500 cu. ft.; lifting capacity per hour, in free soil, 30,000 cu. ft.
Wm. Simons & Co., Ltd., Renfrew.

ports are important, and the only way to preserve the integrity of the channel is to dredge. Sluicing or flushing basins, the gates of which are opened at low tide, have been built at great expense at nearly all these ports, but of late years their use has been very limited, as it has been found more economical and much more satisfactory to dredge, especially as the flushing has a tendency to deepen the channel in the vicinity of the basins, but to deposit the excavated material either inside the jetties or just outside in the channel-way, this deposit taking place by the slacking of the flushing current, which cannot carry its load to the point desired in the deep water of the sea in front of the works.

(f) Deepening river-channels and excavating canals, as in the case of the Clyde from Glasgow to the sea; of the Tyne from above Newcastle to the sea; of the Tees; of the Weiser; of the Sulina branch of the Danube (100 miles from Braila to the Black sea); of ship canals everywhere; of river improvements like those on the lower Danube; and of hundreds of other important commercial undertakings for the benefit of commerce.

Conversely, the conditions of failure in dredging have been:

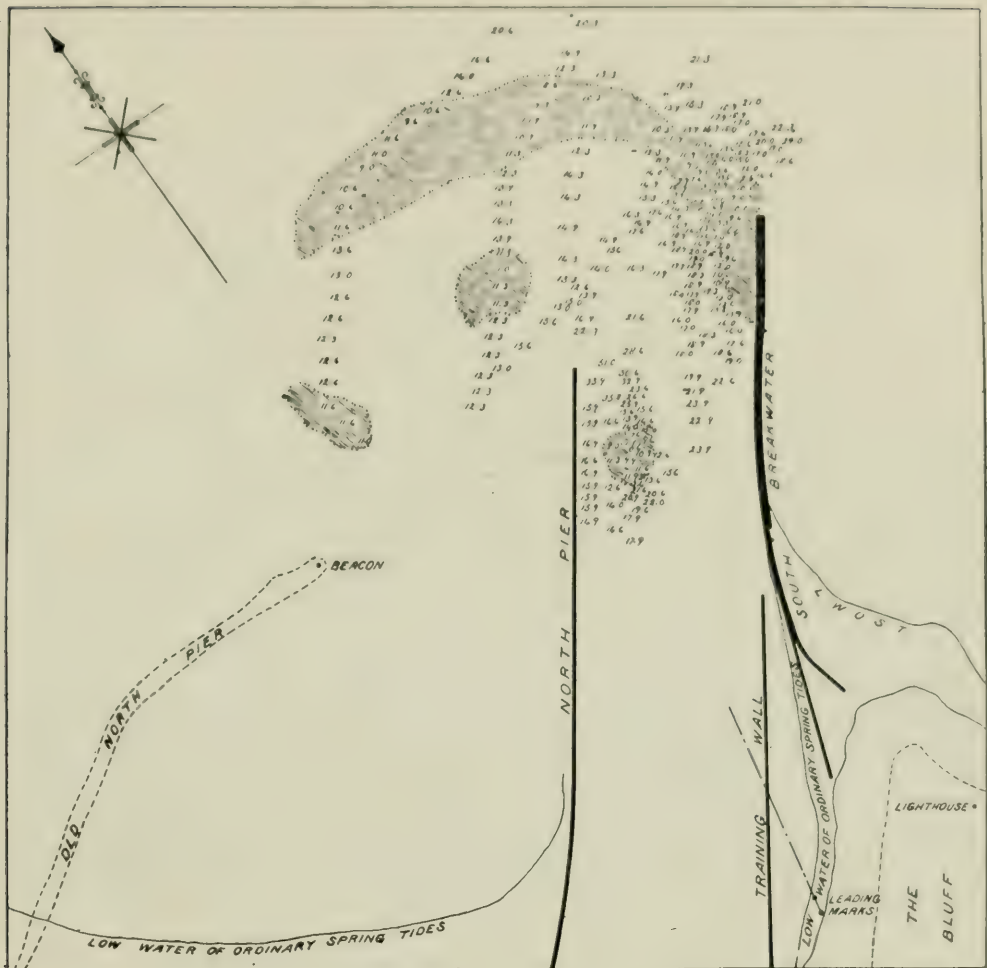
(a) Where the depositing action has made the cost of dredging too great for the commerce to be benefited.

The maintenance of the harbors on the North sea, mentioned above, would, with less commerce, be entirely unjustified; and the questions (often delicate and subtle) as to results of projected works in inducing deposits of sand should be carefully weighed before embarking upon the construction of works on sandy coasts.

(b) Where jetties or breakwaters would so injuriously disturb the regimen of littoral, tidal, and wind currents, and waves, carrying *débris*, as to silt up the harbors.

The building of a breakwater at St. Catherines, on the Island of Jersey, developed injurious shoaling behind it by its disturbance of the normal conditions of the sea currents. It intercepted these sand-laden currents, and induced extensive deposits, leading to the abandonment of the harbor.

The disturbance of the normal conditions by building jetties and a breakwater in front, thus forming a protected harbor, but intercepting the current movements and the passage of sands along the coast, would be likely to lead to great disappointment and the abandonment of the harbor, or to an extraordinary amount of dredging to prevent the area from silting up completely. An added disadvantage and danger exists where rivers, the waters of which are often charged with sedimentary matters,—washings of the country,—empty into the trap formed by the proposed breakwater lying in front. Such plans have always failed to



HYDROGRAPHIC CHART, PORT OF DURBAN, NATAL.

Soundings show location of bar before dredging. Shaded portions indicate less than 12 feet of water. The dredge "Octopus" removed 77,700 tons of sand in the month of November, 1897, and at no point is there now less than 18 feet depth. This dredging also removed much sand from the bight from which the bar was formed, so that heavy storms have as yet caused no perceptible formation of a new bar.

produce commercial harbors. The vast amount of moving sands on almost any sandy coast is not appreciated, until such works develop them by arresting their movement.

SOME INSTANCES OF THE COMMERCIAL BENEFITS OF DREDGING.

Illustrations can only emphasize the fact, patent to every one who makes an examination of harbor and river and canal improvement in many countries, that dredging of navigation channels stands next to the railway as a factor in the commercial development of the civilized world during the last half century. Transportation by sea is accepted as the cheapest means of carrying goods, as well as the most convenient

method of handling large volumes of traffic. It follows, therefore, that estuaries and rivers should be improved, in order to extend the sea traffic as far inland as possible. It may also be noticed that there are very few natural harbors in the world. They are either cut into the solid land, like that of Antwerp and nearly all the harbors of the North sea coast, or they are many miles from the sea, on what were formerly insignificant streams. Within a hundred years there was a depth of only 15 inches at low water in the Clyde at Glasgow, and, 10 miles below, only 2 feet. Newcastle, Hamburg, all the Baltic seaports, are far inland. All this commercial development has been performed by dredging. Wonderful also is the immense amount of work



A SAND-PUMP HOPPER DREDGE AT WORK.

Built by Lobnitz & Co., Renfrew.

done by dredges to open up the great interiors of France, Belgium, Holland, Germany, and Russia, making net-works for canals and canalized rivers, and establishing seaports farther and farther inland. Brussels is to become a seaport ; so is Berlin ; so is ancient Bruges, from whose lofty belfry you can see the dredges cutting a ship canal to Heist and the North sea harbor, now under construction.

Recently the writer, at Budapest, a far inland city, examined the well-considered plans of a harbor with all the facilities of an ocean harbor,—docks (wet and dry), piers, warehouses, and electric cranes. This is for the great barges of the Danube, carrying 1,000 to 1,500 tons. Even Switzerland is to be connected with the Mediterranean and the North sea and Zuider zee, making a harbor at Basel connecting with the Rhone and Main and Rhine navigations of France, Germany, and the Low countries. All this work is done by dredges.

As the dredging appliances improve in economy and capacity, the more extensive will be the improvements for navigation ; what could not be done fifty years ago can now be done with ease.



HOPPER AND BARGE-LOADING DREDGE "ST. MICHAEL."

180x36x15½ ft.; hopper capacity, 12,600 cu. ft.; lifting capacity per hour, in free soil, 9,500 cu. ft.
Wm. Simons & Co., Ltd., Renfrew.

It may be stated as a general rule that, the greater the facilities for navigation, the greater will be the tonnage of ports, and their business and population.

The most pronounced commercial and industrial results of dredging are seen at Glasgow. A lesson may well be learned from the great and continued success there, to be used elsewhere in the world, and where generally the original conditions are much less difficult. The extraordinary physical changes made by dredging will be seen from the fact that in 1755 only small vessels, or "flats," with a draft of 3 feet or less, could reach Glasgow at *high water of spring tides*, while now vessels drawing 27 feet come up on a single tide. Some remarkable physical hydraulic results accompany the deepening of river channels. The tidal flow moves with greater ease in deeper channels. Some of these results at Glasgow may be mentioned, simply as illustrations of what has occurred in many other rivers improved by dredging, though perhaps generally to a less extent. Since 1755 the level of low water at Glasgow has fallen about 8 feet, but the average level of high water has not altered. At present it is about 15 inches higher

TABLE NO. IV.
Statement showing the Progress of Glasgow Harbor, and Docks, Tonnage, etc., of Vessels, Revenue of Clyde Trust, Customs Revenue at Glasgow, and Population of the City of Glasgow; from 1801 to 1897.

DATE.	GLASGOW HARBOR AND DOCKS.			VESSELS ARRIVED			Tonnage of Goods Imported and Exported. Tons.	Clyde Trust Revenue.		Customs Revenue Collected at Glasgow.		Population of the City of Glasgow.
	Lengths of Quays. lineal yds.	Water Area. acres.	Average Depth at Ordinary High Water. ft. in.	Numbers of Steam and Sailing Vessels.	Maximum Draft. ft. in.	Tonnage of Vessels. Tons.		£	s. d.	£	s. d.	
1801.....	382	4	..	.....	....	.....	.....	3,400	10 0	427	0 0	77,385
1811.....	697	7	..	.....	....	.....	.....	4,755	3 8	3,124	0 0	100,749
1821.....	697	7	..	.....	....	.....	.....	8,070	2 2	16,147	0 0	147,043
1831.....	1,543	14	14 6	.....	....	.....	.....	18,932	0 7	68,741	0 0	202,426
1841.....	1,973	23	18 6	.....	....	.....	.....	49,065	15 7	526,100	0 0	255,150
1851.....	3,591	51	20 0	17,274	18 0	1,446,606	1,023,216	68,875	4 9	675,044	0 0	329,096
1861.....	4,376	70	22 0	16,085	20 0	1,504,220	1,366,327	105,768	11 0	924,445	0 0	395,503
1871.....	5,604	75½	23 0	15,800	22 0	2,049,708	1,986,194	164,188	18 7	850,250	0 0	477,732
1881.....	8,422	140	24 0	17,763	23 0	3,057,533	3,053,113	248,061	14 0	1,035,941	0 0	511,415
1891.....	10,753	160½	27 0	16,135	25 6	3,375,109	4,477,506	354,580	11 8	1,391,789	0 0	564,975
1897.....	13,692	205¾	27 0	16,440	27 0	4,082,052	5,673,152	410,190	9 6	1,668,072	0 0	715,579*

* Population within the extended municipal boundary in June, 1897.

at Glasgow than at Greenock, about 22 miles below. Formerly some of the river streets at Glasgow were often flooded during land "freshets." Now, due to straightening, deepening, and widening of the river, flooding never occurs. There is now in Glasgow harbor an extreme range of tide, due partly to winds, of 22 feet. The most marked results are seen in the tidal movements. In 1755 the rise of the tide at Glasgow was only about 2 feet 5 inches. In 1840 spring tides rose 7 feet and neap tides 4 feet 6 inches, while now springs rise 11 feet 4 inches and neaps 8 feet 11 inches. In 1840 the time of high water at Glasgow was 1 hour and 20 minutes later than at Port Glasgow ($19\frac{1}{2}$ miles down the river and the limit of the Clyde trustees' jurisdiction); now it is only one hour. In 1840 the duration of flood tide at Glasgow was 4 hours 30 minutes; now it is 5 hours 55 minutes. The ebb tide was 8 hours; now it is 6 hours 24 minutes.

Another indication of the remarkable change caused by dredging is seen in two float experiments, one in the summer of 1853, when a float put into the river at the beginning of ebb took $43\frac{1}{2}$ tides to reach Port Glasgow, while in 1881 a float, under exactly similar conditions, reached Fort Matilda below Greenock, a distance of $23\frac{1}{2}$ miles, in 7 tides.

Previous to 1844 there was no continuous record of quantities dredged; but, since that date up to June 30, 1897, the entire amount of material lifted and carried away from the river and the harbor and docks at Glasgow was 50,721,710 cubic yards. What have been the commercial results? Mr. James Deas, engineer of the Clyde navigation, who has kindly furnished the writer the data from which the above information was taken, has been good enough to furnish a valuable tabulated statement in answer to the writer's inquiries. This statement, which is given in Table IV, on the opposite page, shows the relations between the Clyde Trust Customs revenue, and population of the city of Glasgow during the period between 1801 and 1897.

It will be seen that most gratifying results have attended the dredging of the river and the harbor and docks at Glasgow. The total tonnage of vessels increased, between 1851 and 1897, 200 per cent.; the tonnage of goods, 450 per cent.; the revenue of the Clyde trustees, 500 per cent.; the customs revenue, 150 per cent.; and the population, 100 per cent.

In respect to the dredging of the river Tyne, the writer is indebted to Mr. J. Watt Sanderson, the well-known civil engineer, of Newcastle-on-Tyne, for the following valuable and carefully-compiled information, furnished on request:

Extent and cost of improvement of the river Tyne by dredging,

between 1860 and 1896, and effect of the same as shown by the increase of commerce and riverside population from Newcastle to the sea.

	1860.		1896.	
	At low water.	At high water.	At low water.	At high water.
Controlling depth of the river between Newcastle and the sea.	0	12 ft.	20 ft.	35 ft.
	Previous to 1860.		From 1860 to 1896.	
Tonnage of dredging done.	2,799,500		96,362,136	
Cost of dredging from 1860 to 1896— not including first cost of dredging plant.	£1,766,639	=	4.4d. per ton.	
	(\$8,597,349	=	8.8c. per ton.)	
Increase of commerce as measured by:				
1st. Increase of revenue of River Tyne Commission.	£66,550		£319,484	
	(\$324,352)		(\$1,554,769)	
2d. Register tonnage of ships clearing from the port.	3,120,265 tons. 1861.		6,752,252 tons. 1896.	
Increase of riverside population from Newcastle to the sea during 30 years.			(Note: The population for 5 yrs. 1891 to 1896 has been estimated.)	
On north side of river.	188,923		363,041	
On south side of river.	104,258		321,847	
	203,181		684,888	

At Rotterdam, the navigation of which has largely been effected by dredging though the Hook of Holland and deepening the Maas, the tonnage has increased from 15,000,000 cubic meters in 1887 to 29,500,000 in 1896,—about 100 per cent.

Antwerp, the facilities of which have been largely furnished by dredging basins in the solid land, has increased its tonnage from about 2,366,000, including inland, coastwise, and maritime, in 1870, to about 9,000,000 in 1896.

The subject is one of great importance, and replete with interest to the engineer. Only the salient features could be stated in the brief space at command. If the writer has been able to draw attention to the subject, show sufficient advantage to commerce, and bring out in some measure the economics of dredging and its very extensive and increasing use, so as to lead to its more extended employment in furnishing commerce with navigation channels and harbor facilities, he will be satisfied with the laborious, but extremely interesting, work of making the examinations and compiling the information.

AMERICAN AND ENGLISH PRACTICE IN ARCHITECTURAL STEEL CONSTRUCTION.

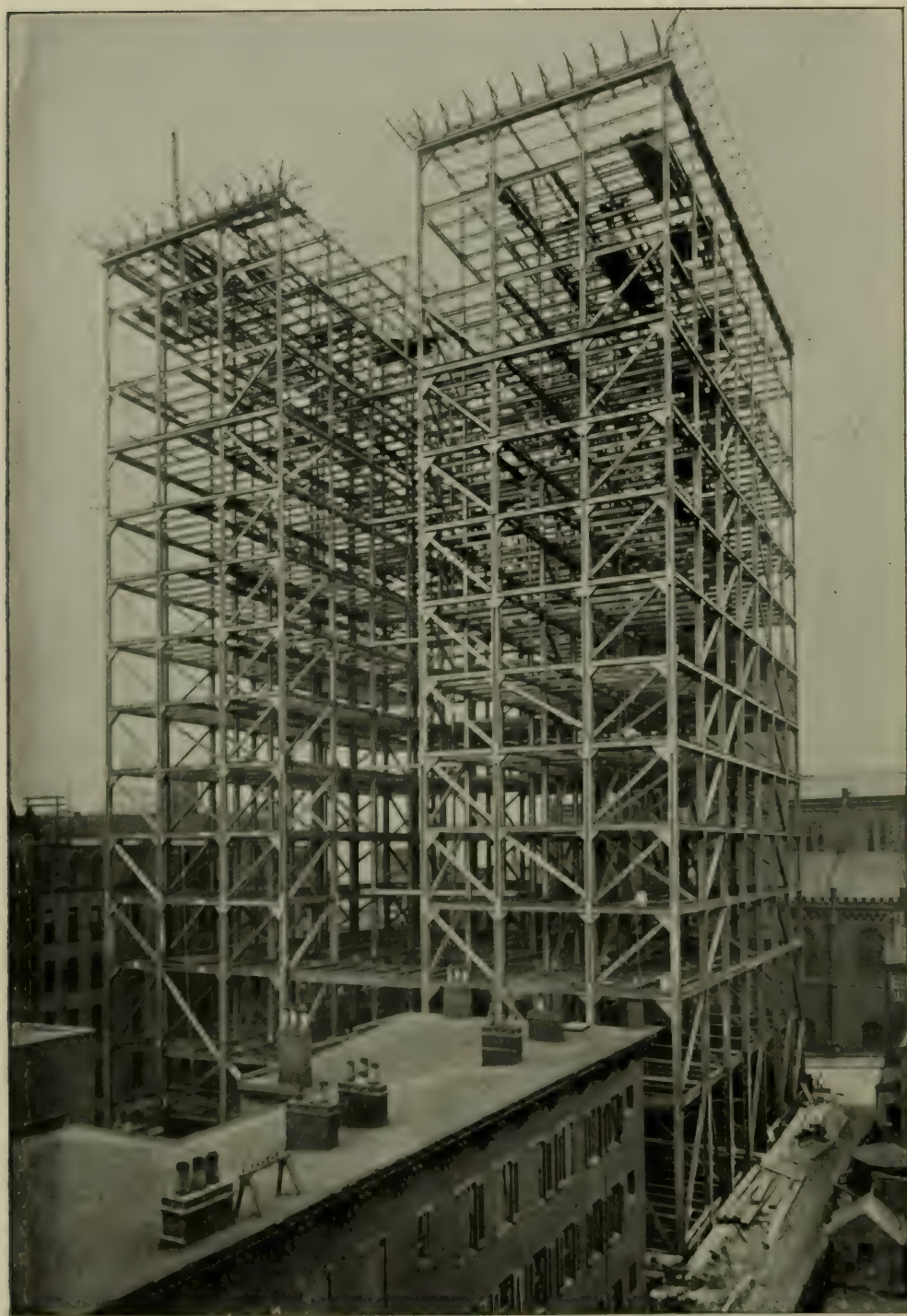
By Charles V. Childs.

TO make a comparison between the English and American practice in architectural steel construction is, to a great extent, equivalent to comparing the present American system to that of eight or ten years ago. Such a statement may be taken to mean that the English methods are that much behind the times ; this, however, is not the true explanation ; it is rather a case of *autres pays, autres mœurs*.

The architects of the different countries being obliged to keep within the limits of their respective building laws, the restrictions imposed on them naturally affect not only the visible appearance of the building, but also its internal structure. While it is highly probable that but few London buildings would come up to the standard prescribed by the New York building laws,—*i. e.*, inside the so-called fire-limits of New York,—on the other hand it is certain that the London County Council would never permit the erection of the steel-constructed “skyscraper” within the area under its control. As an instance in proof of the former statement, it is necessary only to notice how many of the front walls of London shops are carried on bressummers resting on exposed cast-iron columns. The New York building laws provide that all cast-iron columns supporting outside walls shall be incased in an outer cast-iron shell with an intervening air space, the internal column being sufficiently strong to carry the load.

It is appalling to think what the streets of London, already in so congested a condition, would be like, were it permissible to erect buildings fifteen or twenty stories high. The burning question of New York has long been to provide sufficient rapid transit to and from the business centre of the city ; and, while the solution is yet far off, the continual erection of high office-buildings is making matters worse by concentrating business offices within comparatively narrower limits.

The excessive height of the American buildings has necessitated the use of the steel-skeleton construction, in order to economise the weight, and consequently the thickness of the walls in the lower stories, which otherwise would occupy valuable space, to say nothing of the cost of material and labour. The usual thickness of the walls, which, from the nature of the construction, serve only as a covering, is from thirteen and a half to eighteen inches. In England the thickness of



AN AMERICAN TYPE. STEEL FRAME OF THE CARNEGIE BUILDING, PITTSBURG, PA., U.S.A.

wall at the ground-floor-level rarely has to exceed two feet three inches ; if, however, instead of being five or six stories, the buildings were to be three or four times that height, the increase in thickness would have

to be enormous, and the steel skeleton framework would probably come into general use.

The steel construction, therefore, has to adapt itself to the style of building prevailing in the different countries. The essential difference, broadly speaking, is that, whereas in American construction each story is supported entirely by girders at the floor-level of that story,



FRAMEWORK FOR THE HOTEL RUSSELL, LONDON, SHOWING THE 15-TON GIRDERS.

and the weight directly transmitted to the foundations by means of the steel columns (*Anglicé stanchions*), the usual English practice is to place all necessary *bressummers* at the level of the first floor; these, therefore, having to carry the whole weight of the building above this level, are necessarily heavy compound or plate girders. The accom-

panying illustrations,—one of the Carnegie Steel Co.'s office-building at Pittsburg and the other of the Hotel Russell, London, for each of which the steel work was designed by the writer,—show this difference very clearly. Certain of the American features might be introduced into the English buildings with advantage; the difficulty of



STEEL FRAME, PARTLY ERECTED, FOR THE BOVRIL COMPANY'S BUILDING, LONDON.

doing so lies in the fact that the architect's plans are practically complete before the engineer's work begins.

In order to compare the details of the two systems, it will be well to give a description of the American practice, and call attention to its difference from the English practice.

The steel work in an American building begins a few inches above the foundations, and consists of layers of steel beams, embedded in

concrete, to form the piers, on which the steel bases of the columns rest. The bottom layer is so designed that the load is distributed to the ground at an allowable pressure of two or three tons per square foot; this pressure being the same for all piers, any settlement would be uniform throughout the building. In the next layer the beams rest on those below, at right angles to them, and their length is equal to the breadth of the lower layer. The ends of the beams of each successive layer project, and act as cantilevers, their sizes being determined by the intensity of pressure on their cantilever ends. Anchor rods are embedded in the concrete, and bolt the column bases to the flanges of the uppermost layer. By this method the height of the pier is considerably lessened, effecting a saving in excavation and concrete. The tops of the piers are kept just below the basement floor-level, in order to economise room. The English architect depends on concrete alone for his foundations, and, where buildings have been pulled down, utilises the old bricks for this purpose.

In America the space under the sidewalks, being the property of the owner of the adjoining building, is part of the basement floor. The outside walls are carried on lintels just below the sidewalk-level; as each floor is carried on girders independently of the other floors, these lintels have to support only the weight of the ground-floor walls and probably a portion of the ground-floor load. Where the columns carry party walls, it frequently happens that there is not sufficient space inside the building line to allow the column bases to rest fairly on the piers; in such cases the piers are built inside the party line, and the bases of the columns rest on strong cantilever girders bearing on the piers, the other ends of the girders being either counterbalanced by the internal columns or anchored down to a mass of concrete.

In English buildings, on the other hand, the stanchions carrying bresssummers usually rest on blue brick piers, built up to within a foot of the ground-floor-level, and the bases of the stanchions are bolted to York stone plinths. Frequently a sheet of lead is laid between the steel base and the stone. Mention is made of this, because experiments have shown that the practice is harmful; the crushing strength of the stone is thereby diminished, the supposition being that the lead flows into any unevenness in the stone, and acts as a wedge.

The columns in American practice are two stories in height, and the connections are made to break joint alternately at each floor. All connections of columns to columns, girders to columns, and cross-joists to girders are riveted, the riveting gang following after the erection gang, and carefully plumbing each column before riveting

it to the one below. The steel skeleton is thus as much a structure in itself as in the case of a bridge. The London building laws read as follows: "At each end of every metallic bressummer a space shall be left equal to one-quarter of an inch for every ten feet, and also for every fractional part of ten feet of the length of such bressummer, to allow for expansion." Consequently, where bressummers rest on stanchions built into brick piers, slotted holes have to be provided for the bolts.

This theory of expansion, however, is sometimes carried to lengths so extreme that the anchorage of the outside walls to the rest of the building has in some cases been sacrificed; in buildings, especially where the outside walls are carried on bressummers at the first-floor-level, this is of far greater importance than is provision for expansion. If expansion were to take place to the extent allowed for as above, serious cracks would undoubtedly show in the brickwork. The facts that bricks also expand to a limited extent, and that the steel work is, in almost all cases, protected from the outside temperature, should be taken into consideration; the friction between the steel and the brickwork probably equalises their difference of expansion.

The question of wind-bracing does not enter into the English construction, but is an important factor in American high buildings. In the illustration of the Carnegie building it will be noticed that gusset plates are used; the diagonal struts shown are merely temporary timbers, to prevent any possible distortion until the brickwork is built. The usual practice, however, is to connect four columns with lateral bracing, so as to form a tower extending from the bottom to the top of the building. It is questionable whether there is sufficient stiffness, or breadth of base, for this to be of any practical use. In calculating the strains due to wind pressure, the building itself may be considered as a cantilever; the columns in the outside walls, therefore, should be sufficiently strengthened to take up what would correspond to the flange strains in a girder; and, no doubt, the brickwork of the outside walls acts as the web, or counteracts the shear. The brickwork, therefore, should be carefully built round the steel work, and be of sufficient strength to withstand the diagonal pressure, or, in other words, the tendency to distortion which is caused by the shear.

The almost universal practice in America is to space the floor beams six feet apart, and to brace them with rows of $\frac{3}{4}$ -inch tie rods; the space between the beams is then filled in with hollow flat arches, made of firebrick. It is usual in England to space the cross-joists two or three feet apart, and fill in solid with concrete; or, in

order to economise weight and the trouble of centreing, to use one of the many patented floor constructions. The method of connecting the cross joists to the girders depends on the distance between the cross joists. If this spacing is only two or three feet, it is more economical to rivet a continuous shelf angle to the web of the girder; this forms a bearing for the cross joists, and also a support to the concrete filling. Where the cross joists are spaced farther apart, it is more economical to rivet them separately to the girders by means of connection angles.

Slight differences, or, rather, preferences, prevail in regard to the cross sections generally in use for joists, girders, or stanchions, but these are not very pronounced. The English sections of steel joists are, in most cases, heavier than American ones of equal depth. In designing the girders for a floor, provided there were no limitations as regards their depth, American sections would be found somewhat more economical in weight than if English ones were used. If the depth of the girders were limited, as is usually the case, this difference would probably vanish. On the other hand, the English sections, being wider in the flanges, are better adapted to use for rivetted girders, and stanchions. As regards larger girders, compounds (*i. e.*, girders made up of joists and flange plates) are more extensively used in England than in America. This is partly due to the greater concentration of the loads in an English building, requiring heavier girders than are required in an American building, where the girders usually carry the loads of one story only. There also seems to be a preference among English architects for compounds rather than for two or more joists bolted together side by side.

Columns or stanchions vary very much, according to what the manufacturers adopt as their standard sections; as, for example, the Z-bar columns of the Carnegie Steel Company, or the Phoenix Company's columns built up of segmental shapes. In England the sections generally in use are those of a steel joist or joists with plates rivetted to their flanges; or, where the loads are light, of a single steel joist only. Certain joists are specially rolled for this purpose,—*e. g.*, a 9-inch deep joist with 7-inch flanges, weighing 58 pounds per foot, and a 10 by 8 inch joist, 70 pounds per foot. Frequently the joist can be arranged to run through three or four stories, the extra strength in the lower floors being attained by varying the thickness and width of the flange plates, which also may form the splice plates at the joints in the stanchions. These sections are admirably adapted for the connections of the floor joists, and eccentricity of loading is reduced to a minimum; this consideration is really of even greater importance than the arrangement of the metal to give the highest radius of gyration.

Probably, had it not been for the combination among American manufacturers, in the past, to keep up the price of I-beams and channels, these sections would have been more generally adopted by them; but, when the combination was in force, steel columns were displacing cast-iron columns, and, for economic reasons, other sections were adopted, and became, so to speak, stereotyped.

It would occupy too much space to compare all the minor details of construction, but something should be said in regard to the methods of fireproofing. Stone, brick, and steel are not, strictly speaking, fireproof; and, until English architects fully realise this fact and introduce proper fire-resisting material, no building in England will be worthy of the name "fireproof." In America all girders and joists are carefully encased in tiles made of *fireclay*, with an air space, to act as a non-conductor of heat, between the tiles and the steel work. Moreover, the partitions between the rooms and the furring inside the brick walls are of firebrick. The firebrick contract is naturally an expensive item, the estimate for the Carnegie Building amounting to \$50,000 for this portion of the work.

English "fireproofing" may withstand a small fire originating inside the building, but is entirely inadequate to resist a large body of heat, such as may be caused by the conflagration of neighbouring buildings, or the combustion of inflammable material stored within the building.

AN EFFECTIVE SYSTEM OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

II.—THE COLLECTIVE JOB-TICKET ADAPTED TO A DROP-FORGING WORKS.

THE manufacture of drop forgings, although requiring great ingenuity and skill in devising methods and making the dies which produce those complicated and seemingly impossible forms now made from the solid steel bar by the action of one die falling upon another, is a process involving but few shop-departments; hence drop-forging prime and total costs are easily kept by the collective job-ticket alone, provided a general scheme of cost-keeping of sufficient scope and ingenuity to meet the conditions is made a precedent.

Such a general system has been devised by Mr. Foote, of the firm of Strieby & Foote, Newark, N. J., U. S. A., which began business in a small way in 1879, the founders being two thoroughly experienced men,—one a salesman and the other a drop-forgers. The excellent quality of work produced and the good business management have given this establishment uninterrupted success, and for many years it has held an enviable position among American drop-forging makers. It is now employing very nearly its maximum number of hands, and is full of orders. The production was at first almost entirely carriage work, but is now about evenly divided between carriage and bicycle forgings, many of the latter being surprising examples of the art.

Up to 1883 this firm had no thoroughly-formulated system of cost-keeping, and did not know what its actual costs were. The "Beecher rule" for making drop-forging cost-estimates was in force, and Mr. Foote said, in speaking of this simple rule, devised by Beecher, of Meriden, Conn., one of the early American drop forgers, that it gave in average work a wonderfully close approximation to accuracy. Beecher's rule was to add the stock cost, the weight of the rough stock being one-third more than that of the finished work, and the flat labor-cost, and double the sum of these two items for the selling cost. If the work is of about the average description, the rough and ready Beecher rule gives results very nearly correct, but, if the work is very simple and so uses a large weight of stock for the labor involved, the Beecher rule makes the selling price too high, while with little stock and much labor the price is too low.

When the Strieby & Foote management devolved upon Mr. Foote, he speedily became aware of the urgent need of an accurate knowl-

edge of his prime and total cost, and met this demand by the ingenious and comprehensive system which, through his courtesy, is here laid before the readers of this magazine. Precise information like that given by Mr. Foote in regard to the details of his own highly-successful methods of cost-finding and -keeping is of the greatest value to manufacturers at large, and the man who gives it from the certainties of his own thoroughly-tested practice must be regarded as a public benefactor, in highly favorable contrast to those manufacturers who, having cost-keeping systems of their own devising, decline to "give their business methods away," or to "educate the public," forgetting that accurate knowledge of manufacturing costs tends to general prosperity, because it tends to that maintenance of living prices by all which must follow a really accurate knowledge of shop costs. Unquestionably a whole branch of manufacturing trade may be demoralized and rendered unprofitable for a considerable time by the vigorous efforts of two or three rivals, none of whom know what work really costs them, to secure new business. Were these reckless under-bidders aware of the real cost of their own productions, no such condition of affairs could obtain, since it is certain that no manufacturer intends, single-handed, to sell at a loss. Hence it is very clearly to the direct individual interest of every manufacturer who really does employ an efficient cost system to make that system public, because such information educates the public, and so ensures prices under which good management can conduct a prosperous business. It is ignorance, not knowledge, which is to be feared in manufacturing as well as everywhere else and the highest wisdom and most beneficial foresight is to be credited to the really proficient manufacturer who brings his competitors up to his own standard of information.

If a manufacturer had a private system of cost-keeping which was perfect, and which did not cost one cent in operation, even this impossible supposititious condition would not justify him in refusing to "educate the public," because the total expense percentage added by the most cumbersome system of accurate cost keeping is not sufficient to materially affect selling prices.

In Mr. Foote's system of total cost-finding, charges are divided into groups as follows:

(1) Office charges, including all clerical labor, expenses of commercial travellers, and every outlay connected with the office and selling departments.

(2) Factory charges, including all realty considerations, rent, taxes, insurance, and rise or fall of ground values, as well as superintendent's, foreman's, and helper's, or laborer's, pay, and all factory expenses which are not actual labor on output. This account in-

cludes repairs to machinery, coal for engine which drives the shop, all power expenses, and every other item of outlay other than that for the labor of workmen engaged directly in the production of manufactured output.

(3) Manufacturing account. This includes the day wages or piece-prices paid to the workmen engaged in actual output production, the coal used in heating work, which varies very greatly with different pieces and is an important flat-cost item, and pickling and grinding.

(4) Die-room account, including the wages of the foreman die-maker and the workmen under his charge. No charge is made against the die-room for power or use of machinery.

The total factory expense charges are made up by adding the second and fourth items,—the factory expenses and the tool-room expenses,—and this total expense is apportioned among the work-producing tools on an arbitrary work-producing tool-cost basis. For example, a thousand-pound Billings and Spencer drop hammer, costing \$1,200, is apportioned, as its share of daily total expense, \$11.80, this sum being obtained by dividing the total of the three expense items specified by the total cost of work-producing tools, thus making each work-producing tool bear a part proportional to its cost. In case a work-producing tool is subject to an unusually large charge for breakage and repairs, its *ad valorem* expense percentage is advanced arbitrarily, and that of some less hardly-worked tool is diminished to make totals balance.

Thus each work-producing tool in the factory has a certain daily weekly or yearly charge standing against it, which it must earn to keep the establishment out of debt. If a tool is idle, it increases its indebtedness by every hour of such idleness, and this indebtedness is cancelled or paid by the profits gained from work produced by other tools which are earning money while the idler is eating its head off.

Nothing could more strongly emphasize the correctness of recognising the floor-production per square foot of shop-floor area as the true unit of industrial success than the per-day charge of \$11.80 against the idle 1000-pound hammer.

As used above, the "shop floor" means the area of effort, the theatre of those operations which distinguish a factory from a vacancy. While it may be regarded as correct to speak widely of the "square-foot of floor production" as "the unit of industrial success," it is obvious that no shop accounts can be based upon the square foot of floor-area or some multiple thereof, because, while the shop-floor as a whole supports the whole of the industrial aids and operations which distinguish the factory from waste ground, much of

this floor is not used in actual production of finished product. But the floor supports the work-producing tools, and these tools may be substituted for the floor-area in industrial book-keeping. When this is done, as in Mr. Foote's system of shop-account keeping, the all-including "floor-area" is at once divided into wage-earning or money-losing units, which are perfectly defined, and hence are entirely suitable subjects for accounting. When a tool has its daily indebtedness to the shop correctly fixed, it becomes a very easy matter to ascertain whether the tool is keeping even or falling behind its responsibilities.

But the shop economist must be well advanced in true knowledge of factory-production laws before he becomes fully aware that every foot of shop floor, or each tool standing on the shop floor, is under a wage-saving obligation to the shop.

The average shop-foreman, innocent of all knowledge of the actual conditions of shop economy, will say, if his attention is called to the loss entailed by an idle tool, that the loss is trifling. The hammer stands still; it cost \$1,200. Its interest cost per day to the shop is therefore (if the year be held to consist of 250 working days) less than half a dollar; an idle hammer requires no power, no coal, no hammerman; it is in no one's way, and it is costing nothing worth talking about. Such would be the average foreman's statement of the case of the idle 1000-pound hammer, and a concurring opinion on the part of the manager has led many a highly respectable non-cost-keeping firm to bankruptcy. The idle tool costs the shop every day all of its proper apportionment of the shop expense which would be its needful earnings if in operation, and, instead of losing its owners a paltry half dollar per day, the idle 1000-pound hammer costs the shop twenty or more times that sum.

This point cannot be too strongly emphasized, or too often repeated, because perhaps a majority of manufacturers fail entirely to recognise the correctness of this proposition.

But this apportionment of expense per dollar of productive tool-cost is manifestly correct. Here is a certain earning which must be made by a certain number of wage-earners to keep the community out of debt. Nothing can be more just than to say that the greater and stronger worker should earn a greater wage than the smaller and weaker workman. That is the verdict of England's late great strike, and a man and a work-producing tool are equivalents in factory economics. Mr. Foote's system is absolutely correct in giving each tool its daily proportion of the expense account. Time evens all things, and the tool which is bankrupt at the end of one idle week may be even at the end of a month of work, and a large earner at the

end of the year, just the same as the flesh-and-blood workman ; and a day lost by either man or machine is a day's wage lost beyond recall.

Having fixed the proportion of expense to be borne by each tool for each of the 250 working days of the average year, Mr. Foote's system is brought up to the point of considering the three items of flat-cost of production, which are as follows :

(1) Material. Actual weight of stock required to make the piece. Ten per cent. more or less is added to stock-cost as a shop charge for interest, storage, and handling.

(2) Piece price or day wage of the workman who produces the piece.

(3) Coal consumed in heating the work ; actual weight by trial, or estimated weight from record of similar pieces previously made.

These three items make up the flat-cost or prime-cost of the piece. For the total cost the percentage of general expense assessed against the individual tool employed for the time of work-production is added to the flat-cost.

The one arbitrary assumption of this system is that which fixes the individual productive-tool indebtedness to the factory by the cost of the tool itself. Mr. Foote says that the results of the extended trial which has been given this assumption proves its correctness, and it is not easy to find any tenable ground for assailing the proposition. The theory is that a certain value of productive machines must earn enough money to cover the total of the expense charges ; one dollar of this producing-tool value is as good as another dollar, and, on this basis of share and share alike, a tool which costs a thousand dollars should be charged with double the fixed charges on a \$500 tool. The higher-priced tool must, therefore, earn more than the lower-priced tool to keep itself out of debt.

Estimating prices of proposed work involves, first, a reference to the sample boards, which are conveniently hinged so as to shut up like doors, and thus give a great display surface without taking up much floor-room, and which, at the present stage of the existence of the Strieby & Foote Company, contain so vast a number and variety of samples of pieces produced as to make it unlikely that a model will be submitted for estimate which has not an approximation in work done before. Each piece of work made has its shop number stamped on it, and painted in conspicuous letters on the board where it hangs, and is indexed so that the job-ticket on which the piece was made can very readily be found. With the job-ticket for the similar piece in hand, the estimate can be given instantly, as the safe piece price of the manufactured article is given on that job-

ticket. Should there be material variations between a submitted model and the nearest approach to it found on the sample boards, the variation would, of course, be noticed by shading the estimate. But it is no exaggeration whatever to say that the manufacturer, by aid of this collective job-ticket record of past production, can tell within a few mills of what the actual total manufacturing cost of any model of drop-forging within the capacity of his hammers will be.

The Strieby & Foote job-ticket is shown below. This job-ticket

Date, <i>March 20, 1898.</i>					{ No. 3361.	
Article, <i>1,000 Sprockets, No. 2815.</i>						
No.	Operation.	No. of Hours.	Drop.	Rate.	Operator.	Amount.
<i>1,000</i>	<i>Block.</i>	<i>9</i>	<i>H.</i>	<i>40</i>	<i>A. Smith.</i>	<i>4.00</i>
<i>1,000</i>	<i>Blank.</i>	<i>10</i>	<i>"</i>	<i>50</i>	<i>"</i>	<i>5.00</i>
<i>1,000</i>	<i>Finished.</i>	<i>20</i>	<i>"</i>	<i>80</i>	<i>"</i>	<i>8.00</i>
					<i>Coal, 8c.</i>	<i>3.12</i>
		<i>39</i>			<i>2,000 lbs. steel</i>	<i>40.00</i>
						<i>60.12</i>
<i>Inspected—</i>						<i>46.02</i>
<i>1,000 O. K.</i>		<i>B. Smith</i>		<i>39 hours at \$1.18</i>		<i>1.50</i>
<i>No N. G.</i>				{ <i>Punch, 75c.</i>		<i>60</i>
				{ <i>2 hrs, at 30c.</i>		
<i>Can sell for \$15.16 per 100.</i>						<i>108.24</i>
<i>40 per cent.</i>						<i>43.29</i>
						<i>151.53</i>

is "collective" in the widest sense of the term. It gives all shop particulars of manufacture, the coal-cost, stock-cost, labor-cost, tool-cost, and the total cost.

It will be observed that Mr. Foote's system separates the total shop cost from the office charges entirely. His conception is that the office stands in the position of a merchant dealing in finished products only. The wares cost the office so much,—that is to say, the total factory cost. Then to this factory cost the office adds its own expenses and the selling expenses and its profit as a dealer, which gives the total cost, or selling price, viewing the office and factory as parts of the same unit.

The Strieby & Foote collective job-ticket bears, first, the date and order number and name and shop number of the piece. Then comes a line of column-headings, which explains itself. The hammer work, in the example shown, was at piece rates, 40 cents per 100 for blocking out, 50 cents for blanking, and 80 cents for finishing. The coal cost was 8 cents per hour. Two thousand pounds of steel were used,

charged at 2 cents, which was an advance of about $7\frac{1}{2}$ per cent. upon cost at the factory door. This makes a total stock, labor, and coal cost of \$60.12 when the hammerman was done. Then the per-hour share of shop expense for the tool, drop hammer "H," \$1.18 per hour for 39 hours, = \$46.02, is charged. There is a hole punched in each sprocket by B. Smith, who did the work in two hours, at 75 cents per hour, on a press which had a 30 cents per hour charge. These items bring the total shop-cost up to \$108.24. Then the office charge of 40 per cent., covering office and selling expenses, is added, making the total cost for the 1,000 pieces \$151.53. The middle of the ticket bears the memorandum based on this 1,000-piece cost: "Can sell for \$15.16 per 100." The left-hand corner bears the inspector's check of "1,000 O. K. No N. G."

For work in progress the job-tickets stand on edge in a rack of pigeon-holes in the superintendent's office. When a job is done, the ticket and job go to the inspector, and thence to the finished-stores room, the job ticket going to Mr. Foote, who is president and principal stockholder, and is also cost-clerk. Mr. Foote devotes two hours daily to the job-tickets, because these tickets and the information they contain bring him into the closest possible touch with every department of the works. Job-tickets are finally filed and indexed according to the character of the piece. A sprocket order is indexed as "sprocket No.—," not as "order No.—," and filed with all the other sprocket tickets without regard to order number, although of course the latest sprocket order bears the highest job-ticket-number. It is the work of but an instant to compare the per-100 selling cost, or the factory-cost, or stock-cost, or coal-cost, or time-cost in hours required for production of any one sprocket order, with that of another sprocket order, and any notable discrepancy between the cost items of two similar sprockets is at once made a subject for investigation.

Thus this simple collective job-ticket secures to Mr. Foote a permanent and accessible record of all important particulars of every piece of work made in this drop-forging shop. For his personal use Mr. Foote makes up a little book of per-100 prices, but, so far as the permanent shop record is concerned, the collective job-ticket holds everything, and is not transferred to any shop-book of any kind.

Although it is not strictly within the scope of this article, it is well to say here that piece rates are the rule in this shop, and that, once made, they are never changed. On this point Mr. Foote said: "What I want is a large per-hour production, not a small pay-roll. If I have a profit of one cent on a piece, and a man, by exerting himself, can increase the output by ten pieces per hour, I gain ten cents,

and can afford to pay the workman five cents of the ten, and still do better than if the man earned fifty cents a day less money. I am certain that even now some of my hands do not quite dare to extend themselves, for fear that a cut would follow, in spite of my assurances that I want the greatest possible product and am glad to pay for it. I expect to piece work at prices giving a workman \$4.50 per ten hours. If I find I have made a too high piece-rate, I do not reduce it. It is never very much too high. But the next job I piece to that same workman I may rate so that he will have to be industrious to reach the \$4.50 rate, and so even things up a bit, without destroying confidence by cutting a fixed rate."

The die room, which is a very important department in a drop-forging establishment, has been mentioned as charged in total as an item of the manufacturing expense. If new dies are needed for an order large enough to cover the life of the dies, this is correct practice. But, if only a small order is called for, then the customer pays for the dies. In this case there is an earning which does not appear on the job-ticket, but simply goes to the profit side of the ledger. As this item of gain is not very large, and is in favor of the establishment, it can safely be neglected on the job-ticket. As a rule, drop dies are not ordered for small lots of work, but pound their lives out and are replaced by others,—in some cases many times.

From this instance of dies made at the customer's cost, it is easy to draw the general conclusion that special cases and conditions should not be recorded on the collective job-ticket. The information given by the job-ticket is to guide general practice, and should not contain special or abnormal items.

Taken all in all, the writer has never seen any other system of cost-keeping so cheap and altogether satisfactory as that just described. It is but just to the writer to say that at the time of writing the first paper of this series, in which the collective job-ticket was treated as a novelty of the writer's own presentation, he was not aware of Mr. Foote's very complete and admirably simple use of the collective job-ticket, nor did he know of its use otherwise. Mr. Foote's collective job-ticket makes it clear that the writer's assumption of originality was founded, as claims to originality often are, on ignorance of the practice of others. While confessing this ignorance, the writer is pleased to find his suppositions in regard to the possibilities of the collective job ticket so amply sustained by highly successful practice, and practice so simple, so comprehensive, and so cheap that it seems almost an impossibility to improve upon it.

But there are simple manufactures which it seems impossible to cover by the use of the job-ticket.

THE PURIFICATION OF RIVER WATER-SUPPLIES.

By Allen Hazen.

ONE of the most noticeable results of the improved facilities for the transportation of foods and manufactured products is the great concentration of population which has been and is taking place in the larger cities, largely at the expense of the rural population. This concentration of population has resulted in a whole series of municipal questions, upon the successful solution of which depends the future of our civilization.

Among these questions none is more interesting or important, or more directly affects the health, happiness, and welfare of the entire urban population, than that of securing an abundant supply of pure and healthy water.

In the Roman world the importance of pure water was widely recognized, and the remains of the ancient aqueducts are among the noblest monuments of that time. With the disintegration of the Roman empire public water-supplies went out of common use. The conditions did not favor the concentration of population in great cities, and all through the Middle Ages the inhabitants of European cities were dependent largely upon wells for their supplies of water. These wells served as receptacles for much of the filth and liquid waste from the people who used them, and the waters drawn from them were often unhealthy, although this was not realized by the people, who attributed the plague, cholera, and other sicknesses resulting from their use to other causes; and it is probable that wells were finally abandoned not so much because of the badness of the water obtained from them as because of their failure to supply a quantity of water adequate to the demands of increasing population.

When the well supplies in the centers of London, Hamburg, and other cities became inadequate, the first attempts were made at the distribution of water through pipes, which were the beginnings of our modern system of public water-supply. These early public water-supplies were invariably pumped from the nearest river or pond, and from that time until the present the most important sources of water-supplies have been the rivers.

When cities were fewer in number and far less populous than at present, and when sewerage systems were nearly unknown, the pol-

lutions of the rivers were comparatively unimportant, and water-supplies taken from them, even from intakes near the centers of large cities, were less objectionable than the waters from wells previously used ; and so the early public water-supplies, bad as they were, were distinct improvements upon previous conditions.

There are many sources of river pollution, but sewers are, in general, more important than all the others combined. Until comparatively recent times many cities had no sewers: even large cities were but incompletely sewered, and large proportions of their populations were dependent upon earth closets or privy vaults, the contents of which were removed from time to time. Such vaults have been, and are, going out of use, and the use of water closets discharging to the sewers has been very greatly extended. Even small cities are now supplied with these conveniences, and the proportion of people connected with the sewers in the larger cities has been much increased.

It thus happens that, while the urban population upon the watersheds of our rivers has greatly increased, the pollution of the rivers resulting from it has increased even more rapidly ; and the end is not yet reached, for many cities are still dependent more or less upon privy vaults, which are gradually being abandoned, so that we may expect that for some time yet the pollution of rivers will increase considerably faster than the increase in urban population upon their banks.

River waters have probably been, ever since the time when they were first used, more or less unhealthy, but for a long period this was not clearly recognized. With the increasing pollutions their use caused disease more frequently, until at last their unhealthfulness forced itself upon the attention of the people, and the objections to their use have since constantly become more apparent.

Because of the unhealthfulness of river waters in their raw state, some cities have abandoned their use, and have sought unpolluted water-supplies, oftentimes at great distances. Such supplies have been secured most frequently from impounding reservoirs constructed upon comparatively small and uninhabited or nearly uninhabited watersheds. Other cities have secured water from underground sources, and such water, with proper systems of collection, is almost invariably free from disease-producing qualities, although often harder than surface waters, and sometimes containing iron, which makes it less desirable.

Both impounding reservoirs and underground sources of supply require certain favorable physical and geological conditions. To secure a ground water-supply suitable water-bearing rock or gravel strata must be available ; and to get a satisfactory supply from an im-

pounding reservoir a water-shed of sufficient size and nearly free from population must be found, at the outlet of which there must be a suitable reservoir site. If these conditions do not exist, it is useless to think of securing water-supplies in these ways, and the city must continue to use its river supply with such improvements as it may be able to make. Very many of the great cities of the United States are so situated that there is practically no chance of securing ground water-supplies or suitable storage reservoir or lake supplies; these cities must continue to use river waters.

The processes which have been suggested for the purification of river waters are very numerous, but those which have been actually used with success are very few. Practically filtration is the only process successfully employed, and among the types of filters used the type known as the sand filter has been so much more widely and successfully used than any of the others as to give it a unique position.

Sand filters for the purification of municipal supplies consist, in general, of rectangular basins with water-tight bottoms and sides, with underdrains upon the bottom surrounded and covered with small stones, upon which rest smaller stones, and then gravel and finer gravel, and finally a deep layer of moderately fine sand, such as is obtained in many places from river-beds, from beaches, and from sand banks. Arrangements are made for taking the river water over the sand, covering it several feet deep. The underdrains are connected with the reservoirs or pumps, and, as water is drawn from them, and by them in turn from the spaces between the stones on the bottom of the filters, its place is taken by water from above, and in this way an extremely slow and steady flow of water downward through the sand is maintained.

In the passage of the water through the sand the suspended matters are removed, and the water flows out below in a clear and palatable condition. The matters removed from the water gradually accumulate in the sand, until its pores become so far filled with them that water will not pass in sufficient quantity to meet the requirements, and it is then necessary to draw the water off from the top of the filter, and to scrape off the upper layer of sand, which contains the greater part of the matters removed from the filtered water. Afterwards water is again taken over the sand, flowing through it as before. Eventually it is necessary to replace the sand which has been removed, to maintain the layer at its full thickness. Such filters are constructed in groups, and each filter is controlled by gates or other regulating apparatus, so that it can be shut off for the purpose of being cleaned, while the supply is maintained uninterruptedly from the others. Sometimes filters are built with earth embankments, having

sloping sides paved with materials to withstand ice and frost action. More frequently masonry walls are used, thus making a neater and more satisfactory, although somewhat more expensive, construction. The bottoms are commonly made water-tight with concrete, although other arrangements are sometimes used ; where the natural bottom is exceptionally good and there is no danger of loss of filtered water by seepage, the artificial bottom is omitted.

Where the winters are not too severe, filters are built open to the sky, but farther north, where the frost is severe, it is necessary to cover them as a protection from ice and cold. The simple formation of ice on the surface of water upon a filter does not, in general, materially interfere with its operation, but, when it becomes necessary to clean the filter in very cold weather, the ice must be removed at considerable expense, after which the water is drawn off and the dirty sand removed. If during this operation the surface of the sand layer becomes frozen, even slightly, the results which are obtained from the filter afterwards are inferior to those normally obtained. The reason for this is not yet clearly understood, although it seems to be in large measure due to the killing by frost of the organisms most active in purification. The sand of a filter is filled with living organisms, which live in it and feed upon the matters in the passing water, which are at once their food and the matters which make the water objectionable in its raw state, and the action of a filter depends in considerable measure upon the presence and activity of these organisms. When these organisms are destroyed, accidentally or otherwise, in warm weather, it takes but a short time for other organisms to establish themselves in their places, but at the freezing-point bacterial changes go on much more slowly than at warmer temperatures, and the time required for a filter to recover its normal action is much longer. For these reasons the operation of open filters at northern winter temperatures requires some care and skill, in order to secure at all times the best results, and, where the cold is severe, covered filters are necessary to insure at all times a satisfactory effluent. Filters protected in this way are not influenced by frost, and yield effluents of the full standard of purity throughout the year.

The processes taking place in sand filters are very intricate. They can be separated into two distinct and widely different actions or classes of actions,—namely, (1) mechanical or straining actions, and (2) oxidation or biological changes. These actions always take place simultaneously in sand filtration, but their relative importance varies widely in different cases. In removing the mud and sediment generally present in river waters the straining action is the more important, while many of the organic matters, which include the sub-



REMOVING ICE FROM A FILTER.

[The winters of England are not severe, and open filters suffer but little from ice. This photograph of one of the East London filters, taken Feb., 19, 1895, shows the greatest accumulation of ice in the history of the works.



COVERED FILTER IN COURSE OF CONSTRUCTION.

Showing wooden centres for masonry vaulting. (Somersworth, N. H.)

stances that cause tastes and odors, are not removed with any certainty and completeness by straining, but are, under suitable conditions, oxidized or destroyed by the oxygen present in the water, with the aid of the organisms which establish themselves upon the sand grains, and which by their presence cause these actions to take place.

The removal of the bacteria, including the germs of disease, is effected, in part, as a simple straining operation, and, in part, in connection with the biological changes resulting from the presence of very active life upon the sand grains of the filter.

The question is sometimes raised as to the completeness of the purification which can be effected in this way, and whether or not a water once polluted will not always remain more or less injurious to health. It may assist us to arrive at a correct understanding of the power of the processes involved in sand filtration to consider what is accomplished in sewage purification. The comparison is justified, as the waters of many rivers, particularly in dry weather, are simply dilute sewage.

Sewage has been purified for many years and for many cities by filtering it through sand beds intermittently. The oxidation and bio-

logical changes which take place in these beds are similar to those which take place in water filters. They differ principally in their intensity, owing to the greater richness of the food-supply in sewage. The purification which takes place in a well-built and regulated sewage filter is extraordinary. Certain organisms attach themselves to the sand grains and remain fixed while the sewage flows by them, and they take from it, as it passes, the organic matters which form their food-supply and which constitute the most objectionable matter in the sewage. As a result of the assimilation of these matters by the vital processes of the organisms resident in the sand, the organic matters in the passing sewage are removed, and in large measure destroyed and converted into harmless mineral products, the most important of which are carbonic acid and nitric acid, the latter of which combines with the alkaline earths always present, forming nitrates.

It is a matter of common experience that filters of this kind, of sufficiently fine material and within proper limits, actually remove and destroy from ninety-five to ninety-nine per cent. of the organic matters of the sewage passing them, and at the same time remove the



INTERIOR VIEW OF COVERED FILTER.

When in use water covers the sand and rises nearly to the springing line of the vaulting.
(Ashland, Wis.)



CLEANING A FILTER, EAST LONDON.

for ten years, yielding effluents rarely containing more than two per cent. of the organic matters of the sewage, and sometimes not more than one in a million of the bacteria. So complete is this purification under favorable circumstance that, from sewage taken directly from one of the Lawrence sewers, effluents are produced as bright, colorless, and sparkling as any spring water, entirely free from objectionable taste or odor, and generally suitable for drinking purposes. I have drunk such effluents from undiluted sewage at the Lawrence experiment station hundreds of times, and also on numerous occasions effluents from the sewage of cities and towns both in America and in Europe. These effluents have also been drunk by large numbers of persons, and, although careful inquiry has been made, no reason has ever been found to think that the health of anyone has been injured by such use.

What has been thus accomplished with sewage can certainly be accomp-

bacteria even more completely than the organic matters. Large numbers of bacteria find themselves incapable of existing in the presence of the changes taking place in the filter, and thus lose their lives. Others are removed by the straining, and eventually die. At the Lawrence experiment station of the Massachusetts State board of health filters are now in use which have been constantly receiving sewage



PAVED EMBANKMENT BETWEEN TWO FILTERS, EAST LONDON.

lished with the much more dilute sewage which flows in many rivers.

It may be questioned, and with reason, if it will be possible at all times to operate water filters to secure effluents of the greatest purity. Accidents will happen sometimes, and one would hardly recommend the use of purified sewage for the public water-supply of a city.

The answer to such a question is best furnished by reference to the records of the very numerous cities in Europe, and the smaller number of cities in this country, where filters for public water-supplies taken from sewage-polluted rivers have been in use for long periods. Very few cases are recorded where there is reason to suppose that disease was caused by the use of filtered water. The few cases which have occurred are particularly instructive as showing the precautions necessary to prevent the recurrence of the conditions. The most important cases of this kind have resulted from the passage of water around the filters, and not through the sand. Such cases are obviously due to defects in the method of connection or to gross carelessness, and not to any fault in the process of filtration. Other cases have resulted from the use of improper filtering material, or from insufficient depth of filter, and especially from too high rates of filtration. In a few cases reduced bacterial efficiency has resulted from passage of water from above the sand to the underdrains through cracks in the masonry walls, caused by settlement; such results can be prevented by keeping the underdraining material back a little from the bottom of the filter walls, so that, even if water gets down in this way, it will nevertheless have to pass through a certain distance of sand on the floor of the filter before it can reach the pure water channels. Decreased bacterial efficiency has also resulted sometimes from the effect of frost in severe climates with open filters, and in a few cases this disturbance has gone so far as to result in the discharge of water of a distinctly unhealthy character.



RECONSTRUCTING THE UNDERDRAINAGE SYSTEM
OF A FILTER AFTER 26 YEARS OF USE,
BREMEN, GERMANY.



INLET FOR ADMISSION OF RAW WATER TO A
FILTER, EAST LONDON.

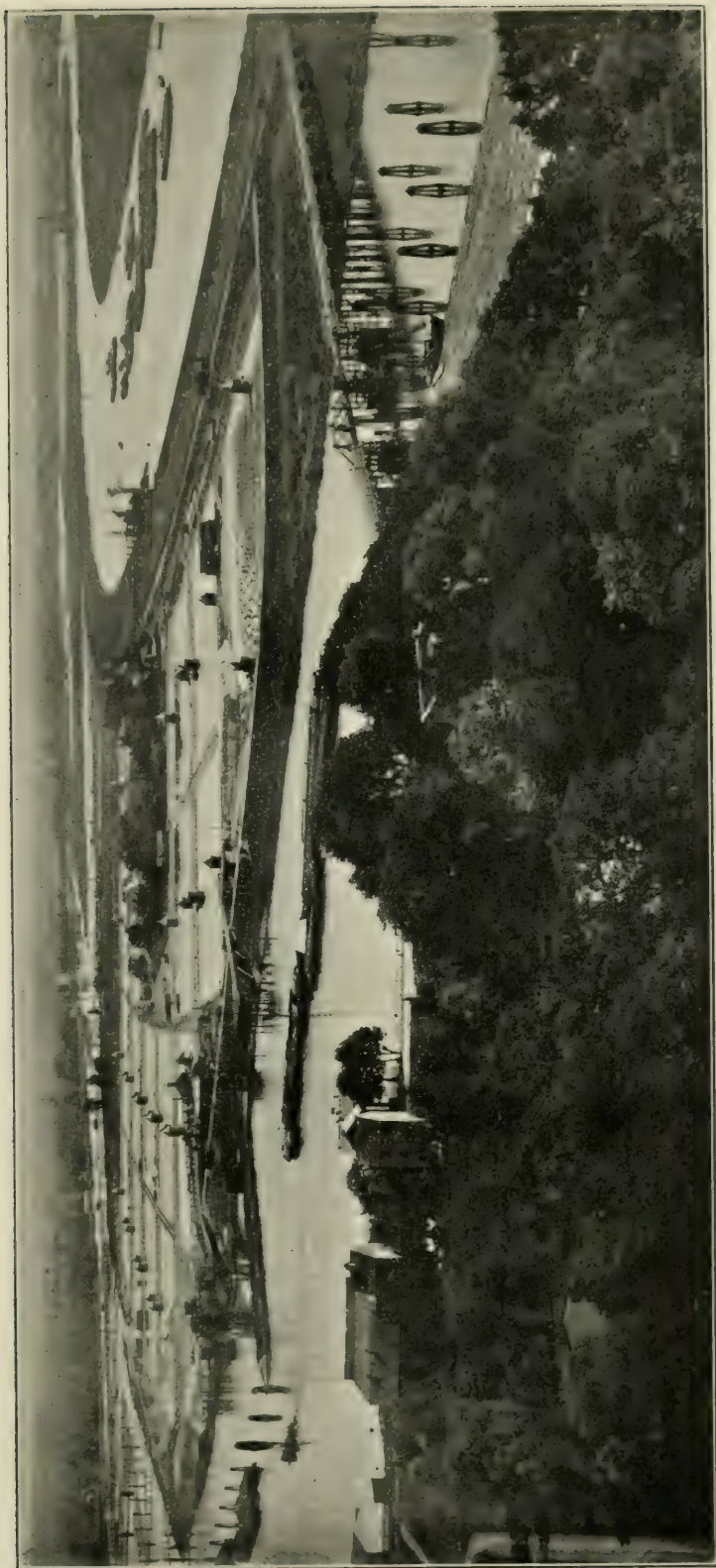
Defects of this kind are of such a character that they can be provided against by careful design and construction, and in the newer filter plants, constructed since the theory of filtration has been better understood, the arrangements are such as to make inferior results from the causes mentioned almost impossible.

In a few cases, where it has been necessary to use waters polluted to an unusual extent, double

filtration has been employed. That is to say, the effluents from filters are carried to a second set of filters, so that there are two lines of protection to the consumers, either of which should be sufficient. In this case the failure of any part of the plant to do its duty need not be followed by any appreciable reduction in the quality of the water supplied.

The question of the quality and safeness of a water-supply is largely a relative one. No supply can be said to be absolutely free from danger. Supplies from impounding reservoirs are subject to various sources of pollution, and often require to be filtered. While it must be admitted that there is some danger from the use of purified water from a polluted stream, there is good evidence that, with the best appliances and manipulation, this danger can be so far reduced as to be hardly appreciable. This is borne out and emphasized by the successful use, by a large number of cities, of purified waters from highly-polluted rivers. To mention only a few cases, London is supplied from the Thames and the Lea; Hamburg and Altona are supplied from the Elbe; Berlin was formerly supplied from the Spree within the city limits; Lawrence is supplied from the Merrimack river, nine miles below Lowell; and Hudson and Poughkeepsie from the Hudson below Albany and Troy. All these cities show death-rates which, so far as diseases conveyed by drinking water are concerned, compare favorably with those of other cities similarly located and having public water-supplies from unpolluted sources.

In fact, it has been stated, and apparently with reason, that, on



GENERAL VIEW OF FILTERS AT HAMBURG, GERMANY.

Water from the River Elbe (shown on the right), then used without filtration, caused the cholera in 1892. The filters now purify this water and protect the city from a recurrence of the attack.

the whole, the dangers attending the use of water from a highly-polluted river, after it has been filtered through a properly-designed filter plant with ordinarily good management, are less than those attending the use of unfiltered water from impounding reservoirs upon the sparsely-inhabited water-sheds used by many cities. That is to say, the unavoidable pollutions of such impounded supplies, among which should be remembered the droppings of birds, wild animals, dogs, etc., and the pollutions from camping parties, in addition to those from permanent population, are in the aggregate a greater source of danger than are such germs as are able to pass through a good filter plant.

It has been said of water that innocence is better than repentance ; but honest and thoroughgoing repentance is not to be despised, and, where the only sufficient sources of water within reasonable distance of a large city are rivers which long ago lost their original purity, we are justified in the attempt to correct the evils. The successes already achieved give promise of a large and useful future to the art of water-purification.

MINING THE GOLD ORES OF THE WITWATERSRAND.

By H. H. Webb and Pope Yeatman.

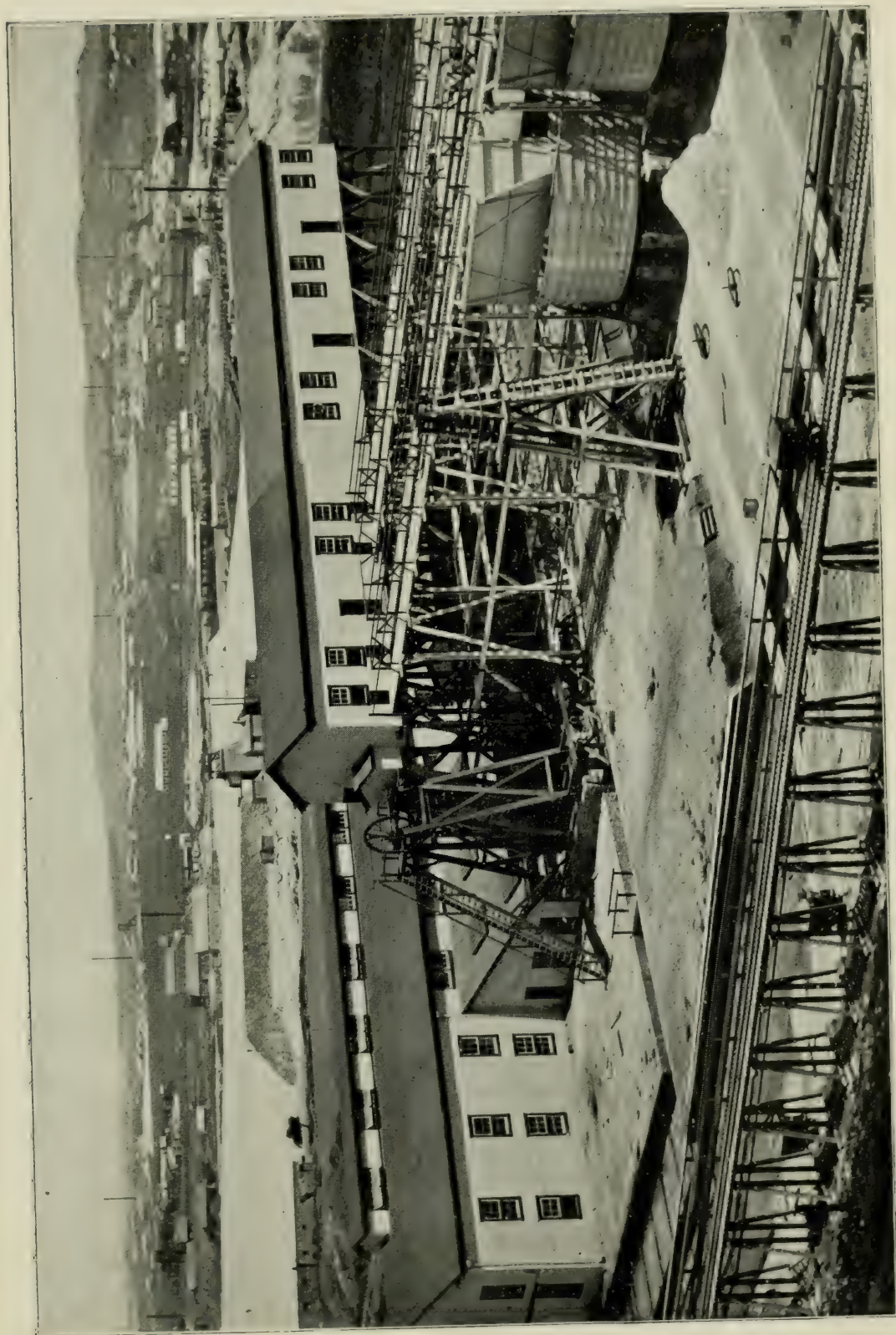
THE mechanical equipment of the Rand properties does not perhaps present marked contrast in types to the equipment of similar plants in other great mining districts. In more distinctively economic features, however, the conditions are more peculiar to the region, sharing in greater or less degree characteristics which mark all localities difficult of access.

Supplies.—If we include under this heading native food, timber, steel, oils, paraffin, candles, ropes, spares of all kinds, chemicals, sundry stores, etc., they will amount to 20 per cent. or more of the whole working costs for mining and milling. Fortunately for the Witwatersrand the percentage of timber used, except in construction, is small. All supplies and material for construction and equipment are so intimately connected with freight rates that the latter have an important bearing on mining costs. It is difficult or impossible to get at the exact ratio of these costs to total working expenses. There are five railroads connecting the Transvaal with different ports on the coast, but within its boundaries all trade is controlled by one company, the profits of which for 1896 have been estimated at almost as much as the dividends of the whole mining industry for that year. In operating expenses freights form probably 6 or 8 per cent. of the total; in construction costs they are a very heavy item. Evidence produced at the sitting of the commission has shown that the charges on timber imported in various forms have averaged from Delagoa bay to the Witwatersrand—a distance of 394 miles—about 300 per cent. of the original cost. On a consignment of pitch pine, the original cost of which was £1,722, the railage amounted to £7,234; on a consignment of Oregon pine, prime cost being £2,988, the railage from Delagoa was £14,500. Seventy-five items of machinery and plant shipped *via* East London—a distance of 666 miles—showed an average railway charge of nearly 37 per cent. of the home cost of the various material, the highest being 469.5 per cent., in the case of Portland cement, a large quantity of which is used in construction, and on which there is also a special Transvaal duty of 3s. per hundred pounds. On these seventy-five items the percentage on home cost of importing charges was 16½.

Explosives. — The government gives the following statistics of consumption of explosives for 1896 on the Witwatersrand alone : dynamite, 33,858 cases of 50 pounds each ; blasting gelatin, 109,598 cases. The dynamite cost 91s. 10d. per case and the gelatin 107s. 4d. per case. The entire quantity is supposed to be manufactured in the Transvaal, a monopoly of this trade being in the hands of one company. Hitherto all the dynamite and gelatin have been imported as such, and made up into cartridges. Of late efforts have been made at home manufacture, from imported ingredients. The quality is, as a rule, inferior, and the action irregular ; foul and copious fumes are emitted, and there are frequent failures to explode, which are a source of danger to life because of the liability to unexpected explosions later. The cost of explosives per ton varies, probably averaging at least 9 per cent. of the total working costs and amounting to from 2s. to 3s. per ton of ore mined. In shaft-sinking an average of nine shafts, 25×6 feet in the clear, showed the cost of explosives as 5.12 per cent. of total working costs, and a cost per ton of rock broken of 1s. 8 $\frac{3}{10}$ d. for explosives.

In stoping we know of two large mines adjoining each other in one of which the cost for explosives per ton of ore milled is 1s. 4d., and in the other of which it is from 3s. 3d. to 3s. 6d., the difference in the latter case being due probably to the use of air-drills. In driving and development generally the cost in opening up a well-managed deep level, preparatory to milling, has averaged from 4s. 6d. to 6s. per ton of rock taken out.

Water-supply. — The question of an ample water-supply is being given more and more attention each year, and even some of the outcrop mines, which, being the first to be worked, had the call on the available water, have been obliged to shut down for short periods during the long droughts, on account of the shortage of water-supply. As the reefs outcrop along the top of the watershed between the streams flowing into the Atlantic on the west and the Indian ocean on the east, there is no large catchment area in the vicinity of the mines, and they are limited to the conserving of water from very small areas during the short rainy season. The amount of water pumped from the mines is small, much too little for the mining requirements, and in the deep levels the amount is still less, in proportion, than in the outcrops. Mr. W. H. Hall estimates that the outcrop ground yields about 50,000 gallons per shaft, the first row of deep levels about 45,000 gallons per shaft, and the second row of deep levels not more than 2,500 to 5,000 gallons per day. Then, too, the mine water is usually very acid, on account of the oxidizing of the pyrites in the ore, so that the boilers and pipes suffer greatly.



AN EXAMPLE OF MINE BUILDINGS.—THE SIMMER & JACK CYANIDE WORKS.

Every endeavour is made to recover all possible water after using ; so, in addition to the main dams for impounding surface water, there are tailings and slimes reservoirs, where the water from the tailings and slimes is caught, to be pumped back to the mill and used over again.

Much capital has been expended in dams. Along every small spruit and dry creek, dams of greater or less extent have been built to catch storm-water. The largest of these are those built by the Rand Mines, the one on the Natal spruit holding not less than 700,000,000 gallons, and being built of masonry.

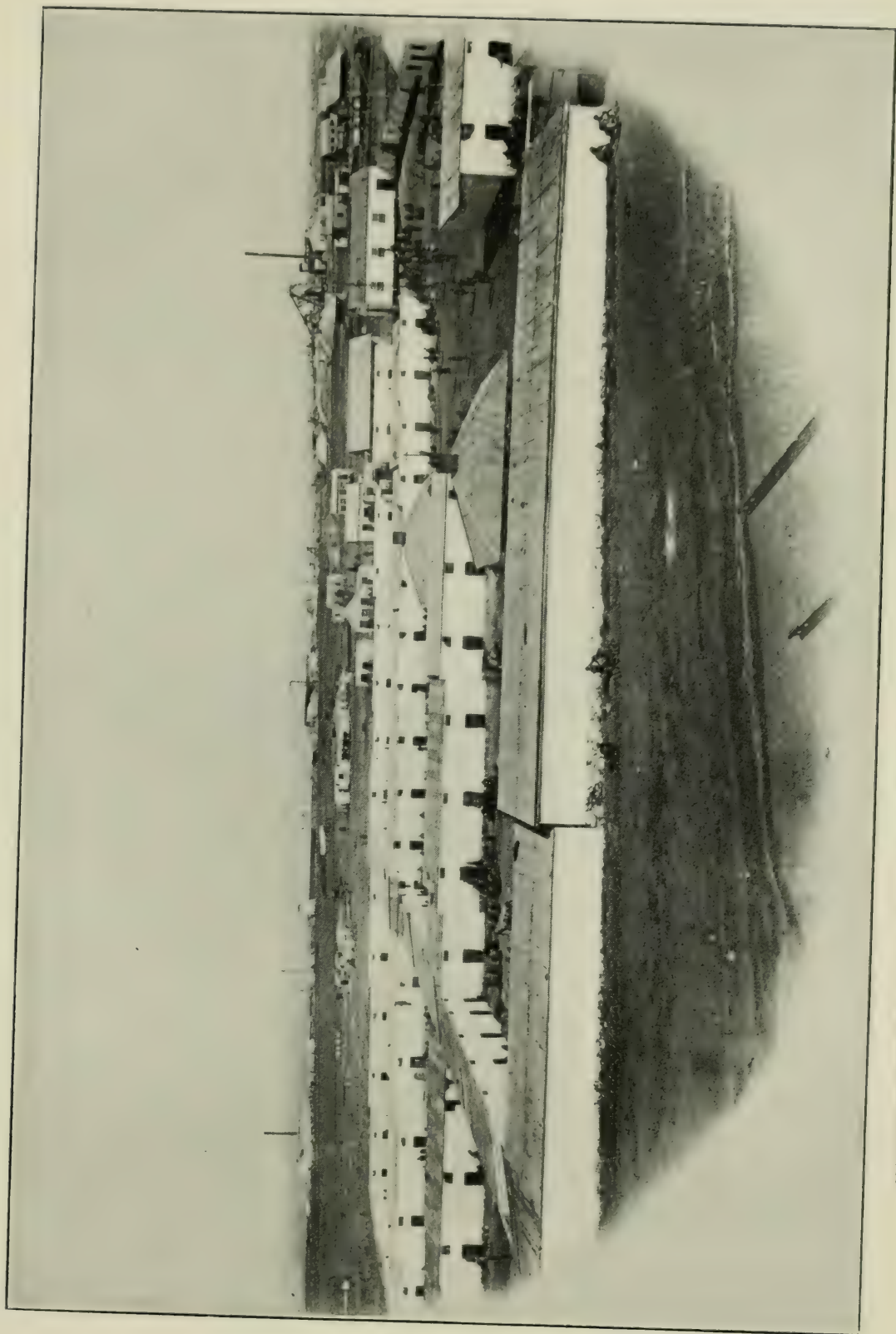
From these dams the water is pumped to large distributing reservoirs, from which supplies are drawn. Though simple in construction, they represent the outlay of considerable capital. They are



MILL AND SURFACE WORKS, KNIGHTS (WITWATERSRAND) G. M. CO., LTD.

partly excavated, and the sides are partly built up of excavated material, and puddled and pitched with stone on the inside.

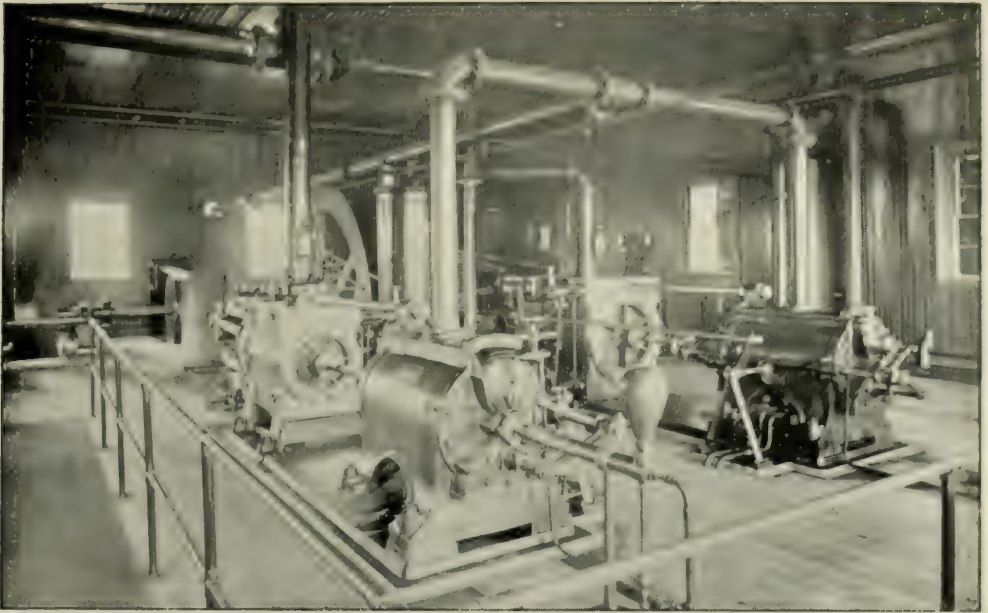
Buildings.—The mine buildings are usually substantial and well designed. They are commonly built of corrugated iron, that material being cheaper than wood or stone, and sufficiently durable. It is customary for the mines to have, in addition to blacksmith and carpenter shops, their own machine shops, and some of these plants are most complete. Each mine has its office and store, and, for its employees, comfortable rooms for single men and cottages for married men. In addition, there are usually very good houses for the officials. On the larger mines recreation rooms are furnished for the employees, and the men are well looked after in case of sickness. There is always a doctor, and on some mines hospitals are erected. Other buildings on the property are for the stamp mill, cyanide plant, etc.



NATIVE COMPOUND, HOUSING 3000 NATIVE MINERS. NEW PRIMROSE GOLD-MINING CO., JOHANNESBURG.

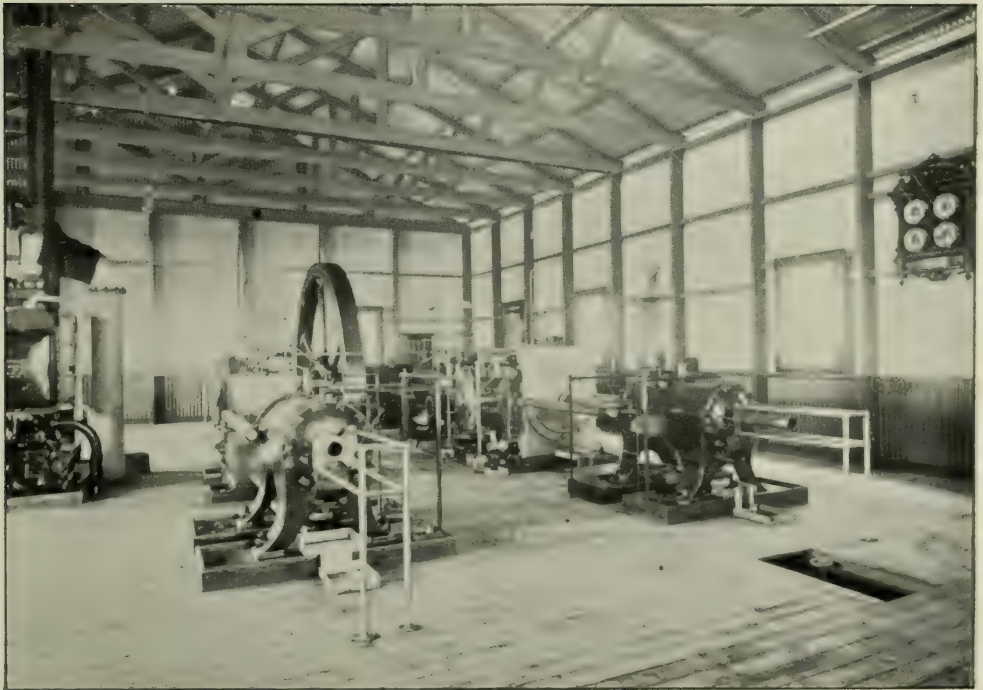


A REPRESENTATIVE SHIFT. ABOUT 5000 NATIVES ARE EMPLOYED AT THESE MINES.



INGERSOLL-SERGEANT COMPRESSOR PLANT, ORIGINALLY EXHIBITED AT THE WORLD'S FAIR, CHICAGO. NOW AT THE CROWN REEF.

White Labour.—Men of many nationalities are found on the Rand, but 80 per cent. of the employees are British subjects. The class of labour is gradually improving, but all white labour may be said to be more or less demoralised, on account of the large amount of manual work falling to the natives. The white man feels it below



A RAND DRILL COMPANY COMPRESSOR PLANT.



PAYDAY AT THE SIMMER & JACK MINES, MIDWINTER.

his dignity to perform any manual labour while a kaffir is about. It is told of one of the most prominent managers on the Rand that, at one time, having a piece of important work to be done and not wish-



HEADGEAR AND ELECTRIC TRAMS, CROWN REEF MINE.



A NATIVE BARBER.

ing to draw off native labour, he detailed some of his best white men to do the job, allowing them one native as a roustabout. Later in the day, on inspecting the work, he found the white men engaged in "bossing up" the nigger, who was the only one of the party who was working.

Nearly every white man has charge of two or more kaffirs; in other words, nearly every man is a boss; but, as a good boss is a rarity, work is not by any means directed to the best advantage.

According to the State mining engineer's report, the number of whites employed on the fields for 1896 was 9,619, including men employed at the mills, cyanide works, and construction and surface work, as well as in the mines; and the total wages paid for white labour was £252,993.

The following schedule shown in the same report gives monthly wages paid for the different classes of work:

Mine overseers	£44.	9.	0
Shift bosses	28.	0.	0
Miners and trimmers	22.	6.	0
Machine drillmen	27.	9.	0
Engine drivers	25.	6.	0
Pump men	25.	10.	0
Stokers	19.	2.	0
Carpenters	25.	18.	0
Blacksmiths	31.	18.	0
Fitters	26.	12.	0
Painters	21.	17.	0
Masons	26.	10.	0
Labourers	18.	11.	0

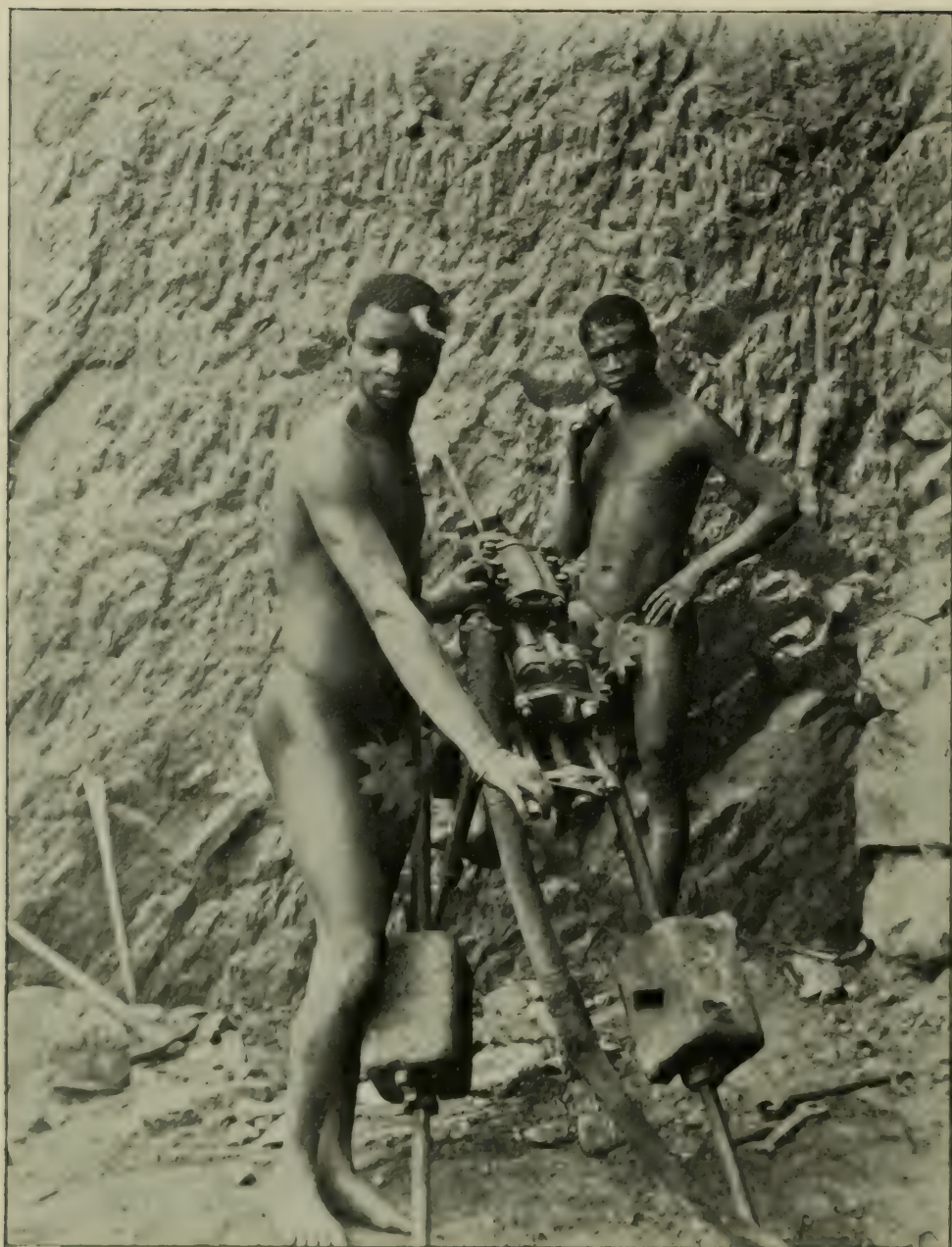
The fields are wonderfully free from strikes. This is due to several causes, the principal being that the government is not in sympathy with the foreign workingman, who has no voice in elections, so that the officials are in no way dependent on the men for their votes. Several attempts have been made in a small way to carry on strikes; but, when any signs of violence or intimidation appear, the police interfere, and the courts sustain their action. That, except in the case of a high class of skilled labour, much of the work of the whites can be done by the natives, between whom and the whites there is



A KAFIR FAMILY AT HOME.



A PIONEER DIAMOND DRILL IN THE SOUTH AFRICAN GOLD FIELDS.



KAFIR MINERS OPERATING A ROCK DRILL.

little sympathy, is an important factor in deterring European labour from striking. The fact that good wages are paid is, as is well-known, not proved by experience to be any sufficient reason for the avoidance of labour troubles.

As shown in the evidence before the industrial commission, the average rate per man paid in a well-managed developing mine is 19s. 6.6d. per shift; in a working mine, about 18s. 6d. In a de-

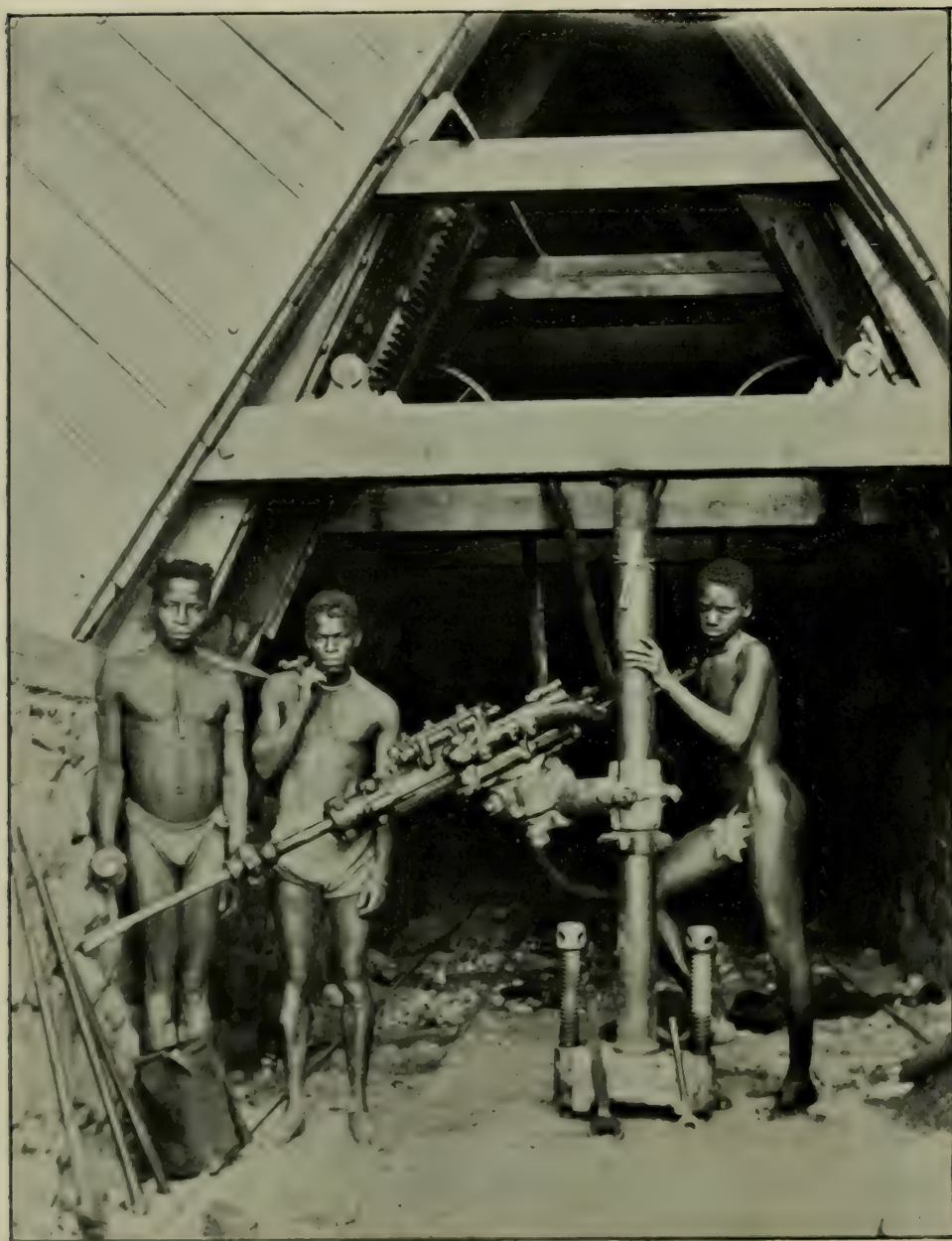


THE WIFE OF A KAFIR MINER, IN FRONT OF HER KRAAL.

veloping mine, and where construction work is being carried on, more skilled labour is required than in a working mine.

Native Labour.—One of the most serious problems on the Rand is the supply of sufficient native labour. The natives are secured from as far south as the Cape and from north of the Zambesi. The proportion from the Transvaal is extremely small. Competition among the mines has been very great, and the result has been a great increase in wages. However, a year ago the managers came together and arranged a reduction, and later in the year a further reduction was made, so that at present the rates paid are not excessive. At certain seasons of the year the supply falls very short, notably in the spring, when the natives are called home for ploughing, and later for harvesting. Then again, in case any tribe is at war, the “boys” belonging to such tribes are called home by their chiefs. For instance, when the Shangaans, who live in Portuguese East Africa, were at war with the Portuguese, the industry was crippled by their being called home to fight.

The natives are docile and intelligent, and it is remarkable how little time it takes to teach them to work, especially to drill. They are used for all kinds of unskilled and manual labour. Of course, the number of untrained “boys” is very large, for the reason that the mines are increasing their working forces, and many of the old



A DRILL IN CHARGE OF NATIVE WORKMEN.

“boys,” when they have made enough money, go home, buy wives, and do not return.

The cost of collecting the “boys” and sending them to the mines is considerable. Some companies have their own collectors; others obtain their natives from independent labour agents; while most rely on the Rand native labour department under the control of the chamber of mines. This association has its agents scattered throughout South Africa, and on the main roads leading to Johannesburg



THE WIFE OF A NATIVE MINER.

their compounds are about a day's travel apart. At these the gangs of imported natives can obtain rest and food. "Boys" coming from Natal, the Colony, Orange Free State, and the Delagoa Bay district are brought in by rail. Were desertion among the boys an uncommon occurrence, and did they remain at any one mine for a considerable period, the cost of collecting would not be burdensome. Were the pass law well administered, desertion would be greatly decreased.

The greatest curse of all, in regard to the native labour question, is that of drink. Early in the week as much as 20 per cent. of the mine natives are un-

able to work, on account of drunkenness. While there is a law prohibiting the sale of drink to natives, it is not carried out.

The "boys" are fed and housed by the companies, and medical attendance is given.

All natives are under the control of a compound manager, who, with a staff of native police, sees that proper order is kept, and that the boys turn out to work. He attends to the food allowance, looks after the sick, and, in fact, is local governor. The natives look on the compound manager as their chief, and his word is law.

A "boy's" food allowance is limited to 2 pounds of mealie meal per day, and 2 pounds of meat per week. The cost for native food averages about 4 per cent. of the total working cost.



KAFIR GIRLS.



RETURNING HOME FROM THE JOHANNESBURG MINES.

Some of these boys come on foot more than 1000 miles, returning the same way loaded with 300 lbs. of baggage. The native miner's code of life is: "Six pieces of white man's gold will buy one cow; four cows will buy a nice little wife; half a dozen wives will tend my mealie patch while I smoke and look on."

The following is the schedule adopted by the chamber of mines for native wages for the mines:

MINE.

	<i>s. d.</i>
Machine helpers.	1 8
Hammer boys	1 6
Shovel boys	1 3
Tram boys (10 ft. trucks)	1 2
Tram boys (16 ft. trucks)	1 6
Dry shaft and winze boys.	1 8
Wet shaft boys	2 0
Wet shaft boys when developing only	2 6
Boys cutting hitches for timber	1 6
Timber boys.	1 2
Stope ganger's assistants.	2 0
Station boys (white man employed).	1 2
Station boys (no white man employed).	2 6
Air hoist drivers.	2 0
Pumpman's assistants.	1 8
Platelayer's assistants	1 6
Pipeman's assistants	1 0

SURFACE.

	<i>s. d.</i>
Stokers (12 hrs.)	2 6
Stokers (8 hrs.)	1 8
Engine cleaners.	1 6
Sorting boys.	2 0
Headgear boys (white man employed)	1 4
Headgear boys (no white man employed)	2 6

GENERAL.

	s. d.
Fitter's boys.....	1 6
Blacksmith's boys (strikers).....	1 6
Blacksmith's boys (helpers).....	1 4
Carpenters' boys.....	1 2
Mason's boys.....	1 4
Police.....	2 6
Compound cooks.....	2 0
Drill packers.....	1 0
Drill sorters.....	1 6
Surface labourers.....	1 2
Office and store boys.....	2 6
Assay office boys.....	2 6
Coal boys (off-loading).....	1 6

Working Costs.—The working costs of the various mines have been collected, classified and tabulated, and from a table prepared by the State mining engineer the percentage of the different items which constitute working costs of all the mines on the Rand for 1895 are given as :

		Per cent. of Total Cost.
White labour.....	£2,400,000	34.3
Kaffir labour.....	2,000,000	28.6
Coal.....	700,000	10.0
Explosives,—i. e., dynamite and gelatin.....	600,000	8.6
Mining timber and sawn lumber.....	300,000	4.3
Cyanide.....	240,000	3.4
Meat, mealie, and mealie meal (being for most part food for kaffirs).....	250,000	3.6
Iron.....	85,000	1.2
Candles and paraffin.....	95,000	1.4
Tools.....	70,000	1.0
Steel....	65,000	0.9
Mercury, zinc, and other chemicals.....	45,000	0.6
Caps, safety, ropes, cement, etc.....	150,000	2.1
	£7,000,000	100.0

By comparing the costs with the output, the cost per ton both for mining, milling and development may be deduced, and a total average working cost per ton found, which will serve to show the progress which has been made in successive years in the mining operations of the region.

Such an analysis has been made by Mr. Jennings, and tabulated in a detailed manner, giving not only the percentage of total cost for all the various items of expenditure, but also the proportion per ton milled, enabling a very clear idea to be obtained of the relative importance of the different portions of the expense account.

In Mr. Jennings's evidence before the industrial commission the following analysis of the working expenditure of six prominent companies is given for 1896 :

	Cost per ton. s.	Per cent. of total cost.
Native labour	6- 9.62	23.73
Native food	1- 2.24	4.14
White labour, salaries, etc.	8- 7.78	30.18
Coal	2- 4.35	8.24
Dynamite	2- 10.13	9.92
Fuse and detonators	1.97	0.57
Cyanide	8.12	2.36
Zinc	0.62	0.18
Mining timber	2.98	0.87
Timber deals, etc	4.05	1.18
Steel	4.21	1.22
Oils, grease, and paraffin	3.73	1.09
Candles	4.15	1.21
Ropes, steel, and manilla	0.93	0.27
Electric spares	1.47	0.43
Mill, spares, shoes, dies, cams, cam shafts, stems, mortar boxes, screening, etc.	4.59	1.34
Trucks, wheels, and rails	2.24	0.65
Sundry stores, bar iron, bolts and nuts, buildings, ma- chinery, assay, chemicals, pipes and pipe-fittings, etc. 2-	0.73	7.19
General charges : insurance, licenses, rent, printing, and advertising sundries....	1- 5.99	5.23
	28- 7.90	100.00

From the same evidence the average of twenty-nine companies is given at 13s. 4d. for mining per ton milled, and mine development and redemption at 4s. 3.5d. ; the total average working cost per ton is put at 27s. 4d.

More recent reports show a general lowering tendency for 1897 :

Simmer & Jack..... 20s. 6.67 d. per ton.

The Geldenhuis Deep..... 21s. 2.594d. per ton.

The Meyer & Charlton..... 18s. 11.654d. per ton.

Reductions.—The question of possible reductions is one that admits of so many ramifications that exact estimates are out of the question. The very cost of living, which is directly proportional to the cost of food stuffs, and which has a direct influence on the wages paid, has an important bearing on the mining industry and the government itself.

In the Transvaal agriculture seems almost a dream, and a farmer has been known to answer, when questioned why he did not increase his little acreage : “ What is the use ? an increase in production will tend only to bring down the market price.” This in a country where hay sells by the pound and averages £20 per ton, and where corn is imported from America, butter from Sweden, and canned goods of all descriptions from the outside world. With a fine market ready to pay extravagant prices, the necessities of life are, in a very great measure, imported. As a consequence, as shown by Mr. Goldman at

the sitting of the commission, out of a total of 3,620 white miners employed by 53 companies, 12.9 per cent. are married men living on the properties with their families, 33 per cent. married men on properties without their families, and 54 per cent. single men.

The single industry of the country is mining ; the government is supported by mining, and the country, as a whole, lives on the industry, with little effort to supply from within the demands created by it. The possibilities are great. Immediate reductions in mining costs might be effected by cheapening coal and dynamite and lowering freight rates and wages. The price of coal can be reduced by cheaper production at the collieries, by shipping in bulk instead of sacks, and by sidings at both the collieries and the gold mines. That of dynamite would fall, if the market were thrown open to the world and freight rates were reduced. Freight rates will decline when there is a spirit on the part of the railway to meet the requirements of the mines. The possibility of the expropriation of the railway by the government has probably had the effect of creating the desire to make all possible profits before such action should be taken.

It does not seem too much to expect that within the next four or five years the average cost of working Rand mines will fall to 18s. per ton. In the case of certain favoured mines a cost considerably less may be effected ; at certain mines this figure has already been reached.

In estimating the cost of bringing a property on the Rand to the milling stage at the present day, the outcrop companies can hardly be taken as a criterion, having established plants varying in age and design. For the deeps, while the surface equipment will remain much the same as regards mill, cyanide, and slimes plants, the cost will vary with the depths to reefs,—that is, cost of sinking, shaft equipment, etc.,—and underground installation for excessive depths on the incline. The sum for fully equipping a deep level and bringing it up to the milling point may be said to vary upward from £500,000, depending on the number of shafts, depth to be sunk, and the size of the milling plant, the tendency being to lay down mills of more than 100-stamp capacity.

APPLICATIONS OF ELECTRICITY ON A MODERN WARSHIP.

By George H. Shepard.

THE auxiliary machinery of naval vessels is operated, in by far the majority of cases, by the direct application of steam ; and, while various auxiliaries are driven by other means in certain ships, there is no purpose for which the auxiliary engine is not now much more commonly driven directly by steam than by any other means. This, too, in spite of the fact that there are many reasons why such application of steam is very objectionable.

The presence of steam and exhaust pipes anywhere outside of the main engine and boiler compartments is undesirable, especially in the crews' living quarters, where the heat that they produce in confined spaces densely inhabited is particularly bad. In addition, the presence of such steam machinery as the ice-machine and the ship's ventilating blowers in the crews' space, where it is generally necessary to place them, adds to the work of keeping the ship clean, both the blowers and the ice-machine requiring the presence of an attendant, whose time is mostly employed in cleaning up the oil and water about them. These, however, are minor disadvantages. A greater one is the obvious danger from steam-pipes above the protective deck, in action. This is met by placing below the protective deck all auxiliaries whose use would certainly be necessary in battle, and by shutting off steam from all the rest below the protective deck when the ship is cleared for action ; but the capstan and the winches must be on deck, and their use may become imperatively necessary in action. In one ship, to the writer's knowledge, the ammunition-passing rooms are so warm that, to keep the men stationed there from giving out, the ventilating blowers, though above the protective deck, instead of being shut down at "General Quarters," have to be run up to twice their usual speed. The cutting of the steam pipe, above the protective deck, to any of these machines would render at least one compartment entirely untenable until steam could be shut off from below, to say nothing of the probable loss of life and disastrous moral effect. By far the most serious objection to these auxiliaries, however, is their lack of economy. Everybody knows they are wasteful, but just how wasteful it is difficult to say because of the rarity of tests under service conditions. The only data that we possess concerning naval auxiliaries under such conditions are the results obtained by Passed

Assistant Engineer W. W. White, United States navy, in a series of very careful experiments on the auxiliaries of the Minneapolis, made a little more than a year ago. In these experiments the condensed exhaust was measured and indicator cards were taken from thirteen different auxiliaries, beside the dynamo engines, including main and auxiliary air and circulating pumps, pumps for feed, fire, bilge, flushing, and water-service, one forced-draft blower, and the ice-machine. The mean result from these thirteen was 99.522 pounds of feed-water per i. h. p. per hour. The greatest economy was shown by the middle circulating pump engine, a simple, vertical, two-cylinder, inverted, direct-acting engine, with slide valves, actuating two centrifugal pumps. At the time of test the pump was working under its full load. The consumption was 55.06 pounds of feed-water per i. h. p. per hour. The least economy was shown by a horizontal duplex pump, 12 inches by 8½ by 10. At the time of test it was making an average of 12.7 double strokes per minute on a very light load. Its consumption was 318.68 pounds of feed-water per i. h. p. per hour.

In discussing Mr. White's paper when it was presented before the American Society of Naval Engineers, Mr. Charles Ward said :

“The resulting data are certainly startling. We have, of course, always known that the auxiliaries were fearfully extravagant in the use of steam, but who supposed that there were engines to-day using from 100 to 300 pounds of steam per i. h. p. ? In the paper before us, giving the summary of tests to determine the consumption of steam of the main and auxiliary engines, we find there are thirty-four auxiliaries having in all fifty-two steam cylinders. Thirty-one of these engines were indicated, giving an aggregate of 471 h. p. developed, using collectively 56,049 pounds of water per hour, or an average of 119 pounds per i. h. p. Were these auxiliaries as economical as the main engines, 9,891 pounds of steam would have developed the same power. 46,158 pounds of steam or water being used *more than is necessary* if the best conditions of economy prevailed ! In other words the data show that at 8 pounds evaporated per pound of coal, 5,769 pounds of coal can be saved per hour.

It must, of course, be borne in mind that it is impracticable to realize this gain because of the complications which would follow the introduction on board ship of high-expansion engines for these numerous purposes, but one is forced to put the question : ‘What are you going to do about it ?’ Shall these numerous engines for as many purposes be brought together in fewer engines of higher character and have a few central power plants capable of meeting similar wants with greater economy ; or shall we design more economic engines for each individual condition, even at the cost of slightly increased number of

parts ; or shall we have one more economical central steam plant developing power to be distributed by electricity to the varied requirements in different parts of the vessel?"

Wastefulness is inseparable from any system requiring the development of power in numerous independent engines of small power situated at a distance from the boilers. Under such circumstances the losses by radiation and condensation must necessarily be greatly increased. Then, too, the use of numerous small engines causes a great increase of the friction load. Worst of all, each of such small engines must be large enough to do its maximum work ; hence, under service conditions, it must often work at low powers with great waste of steam.

These troubles can be avoided by the use of one power plant for all the auxiliaries. Such a plant for a large man-of-war could be divided into a sufficient number of units, so that the generators in use could always be working at nearly their full load ; and at the same time the units would be so powerful that compound engines could be used with consequent economy. In addition there would be the gain from the substitution of a few large engines for many small ones. The plant, of course, would be placed near the main boilers, avoiding much steam pipe drop and condensation, would be below the water-line and well protected, and would keep its heat, dirt, and noise where they belong—in the machinery space.

Now, the dynamos for electric lighting must, of course, continue to be run by steam. In order, therefore, to run the central power plant to the best advantage by keeping its load as nearly uniform as possible, the distribution to the other auxiliaries should also be by electricity. By this means, when the night's lighting load goes off, the day's motor load could be put upon the same generators, instead of running two sets of generators, each at light load and heavy load alternately,—a necessity under any other system of distribution. There would, of course, be variations in the load ; but electric light and power stations equipped with several units, operated by condensing engines, can run under wide variations of the total load, without greatly changing their steam consumption per i. h. p. Electricity is very adaptable to the conditions existing on board ship. The wires can be carried through water-tight bulkheads with less damage to the latter than that caused by the pipes necessary for any other system of power distribution. For the short distances on board ship the transmission losses are negligible. In starting machinery electricity can be applied with a quickness, certainty, and safety attainable with no other power, except possibly compressed air. Distant motors can be controlled from the central station. Moreover, the electric wires are,

of all transmission mains, the least liable to injury in action ; and, if cut, the worst result is the stopping of the motor, or the extinguishing of the lights.

Yet at present electricity is hardly used on naval vessels, except for illumination, searchlights, interior communication, and some signals. Many vessels have special small ventilating blowers operated by electricity, usually in out-of-the-way-corners where the need of extra ventilation was discovered after the ship was placed in commission. Besides this, some ships have electric turret-turning machinery, electric control of steering engine, and so on. This is about the limit. It must be admitted that, from experience with such plants, most naval officers regard electric machinery on ship-board with distrust. If such distrust were justified, it alone would be a sufficient reason for condemning electric installations, for naval machinery must, of all things, be reliable. No advantages can justify the use, in an important auxiliary, of a motive power that is likely to fail in action or to require frequent repairs in peace cruising ; but the dislike for electric machinery apparently arises from the fact that the electric call bells and telephones on board ship seldom work, and that faults in the electric mains are hard to locate. The electric-lighting plant generally works as well as any other apparatus on board. Repairs to the dynamos are not uncommon, but they are usually required by the engines rather than by the dynamo proper, on which the repair work is generally limited to filing the brushes and smoothing and cleaning the commutators. Sometimes a small motor will call for almost constant overhauling and repairs, but there is often a direct steam-driven auxiliary to match it in this respect. It cannot be said, therefore, that naval electric machinery deserves a bad reputation. In fact, the policy of the navy department is, with due prudence and conservatism, to reach out after further applications of electricity, as may be illustrated by the following extract from the annual report of the chief of the United States bureau of construction and repair for the fiscal year ending June 30, 1897. He says : " A question which has received a great deal of consideration during the past year, and which has been the subject of much discussion, is that of the most desirable and efficient power for turning turrets. With all nations, and particularly with this country, the question of turret-turning gear is largely in an experimental stage, and opinions differ as to which is the most desirable. The original designs of turrets naturally provided for steam turning gear, receiving its motive power direct from the main boilers. In more recent years hydraulic, pneumatic, and electrical motors have been put forward, and each system has been given a trial on one or more ships. Electrical turning gear has been adopted by the

English, French, Russian, and German navies for small turrets, and by the French and Russians for the larger turrets of some of their recent vessels, each, however, still also using hydraulic gear for heavy turrets. The only departure by the English, apparently, is an experiment for assisting the hand turning gear by means of a 5-h. p. motor in the case of the heavy turrets of the *Prince George*. In January, 1896, the department decided, in order to obtain the best possible information as to the comparative merits of steam and electrical turning gears, to install both on the cruiser *Brooklyn*, two 8-inch turrets being operated by steam and two by electricity. Thus far the results seem to favor the electrical mechanism, the principal advantage being in the certainty and accuracy with which it may be operated. The department has since decided to equip battleships 5 and 6, *Kearsarge* and *Kentucky*, with electrical motors throughout the turrets, for controlling all operations, and, as this includes 13-inch turrets super-imposed with 8-inch turrets, the test is by far the most severe that has yet been applied by any government, and, if successful, will no doubt establish the superiority of the electrical mechanism. Nevertheless, considerable experiment is involved in this case, and the bureau has thus far urged that it be confined to these vessels, until some definite data are obtained, although it believes that the electrical system is probably capable of greater progress and improvement than any other now in use."

It must be admitted that the conditions on board ship are very trying to electrical appliances. Salt water, salt air, steam, heat, coal dust, and oil combine to produce rapid deterioration. Besides, the weight must be kept at a minimum, and there are no manufacture or repair shops at hand to remedy defects. To meet the conditions, a special marine installation has been developed. The marine generator is a special type, multipolar to reduce the weight and speed, compound wound for self-regulation, and fitted with a field rheostat to provide against changes of resistance of the field coils with changes of temperature. The insulation must be especially good throughout, because it is the weakest point under the conditions noted above, because the electric wires, once laid, are mostly very inaccessible, and because faults in them are hard to locate. The insulation resistance of the armature and field coils, above all, has to be carefully inspected and tested, and should not be less than one megohm. The importance of the dynamo-room requires that it be placed below the protective deck, and consequently it is one of the hottest places aboard ship. The naval specifications, therefore, allow a maximum temperature rise above the surrounding air (measured after a full load run of at least four hours) of only 50° F. in any part of the dynamo. Under the un-

favorable conditions no more can be allowed without risking an internal heat, that, in time, would ruin the insulation and necessitate extensive repairs.

Special appliances of marine type have also developed,—switches, junction-boxes, stuffing-tubes, etc. The switch-board is of prime importance. No wood or other combustible material can be allowed in its construction, and the body of the board must be made of slate or marble.

The wiring is the most difficult and expensive part of the installation, and requires the best materials and the most skilled workmanship. Experience has shown that a two-conductor, insulated, metallic return system is necessary. Attempts have been made to use cheaper and more convenient systems, but without such success as to warrant their adoption on vessels of war.

As might be expected under such circumstances, the first cost of a marine electric plant is very high,—about 100 per cent. greater than that of a similar shore-plant.

In spite of the obstacles in the way of so extensive an electric installation aboard ship as would be necessary to drive all the auxiliaries, the economy attainable is sufficient to make it well worth consideration. A good compound engine, working at nearly its full load, will indicate 1 h. p. for every 20 pounds of steam used per hour. In fact, many such engines have developed 1 h. p. on 18 pounds of steam per hour. For the combined efficiency of an engine and dynamo, direct connected as aboard ship, 82 per cent. is a fair figure; for a motor efficiency, 88 per cent. Taking these figures, we find that, with such a plant as is mentioned above, 1 h. p. could be developed by the motors for every 27.75 pounds of steam consumed by the engine per hour. In Mr. White's experiments the lowest steam-consumption per i. h. p. per hour found in any auxiliary was only a trifle less than twice this amount; and the mean consumption found, omitting the dynamos, was more than 3.5 times as much. With the present small electric installations, it has not been worth the increased weight and first cost to run the dynamos with other than simple engines; therefore, in combining the lighting dynamos with others in one central plant, there would be the gain of compound engines over simple ones of the same power. Theoretically, this would be only about two pounds of steam per i. h. p. per hour; but, in Mr. White's experiments, even after fitting the dynamo engine pistons with packing rings to increase their economy, they still showed a mean consumption of 71.65 pounds of steam per i. h. p. per hour.

As vessels of war spend by far the larger portion of their time in port, any estimates of expenditures for auxiliaries must be based on

port, rather than sea, conditions. A careful estimate, based on Mr. White's experiments, shows a consumption in port of about 6,000 pounds of steam per hour by the Minneapolis's auxiliaries, excluding the steam boats, but including the condensation in the auxiliary steam line. If this ship had a central lighting and power station, furnishing electric power to all the auxiliaries, and operating with the efficiencies estimated above, the corresponding consumption of steam would be reduced to about 1,600 pounds per hour. The Minneapolis burns in port about 33,000 pounds of coal per day for all auxiliaries except steam boats. Assuming the coal- and steam consumption to diminish in the same proportion, with a central lighting and power station and electric transmission, about 8,700 pounds of coal per day would run all the necessary auxiliaries in port, except steam boats, effecting a saving of about 24,000 pounds of coal per day. It is hard to estimate the average price paid for coal by naval vessels, on account of the widely-varying prices in different parts of the world; but seven dollars a ton would be below rather than above the truth. At this rate, the saving to the Minneapolis would be about seventy-five dollars a day in port, and somewhat more at sea.

However, in a question of economy, first cost must also be considered. In changing from direct steam-driven to electrical auxiliaries, we should not only be changing to a system that is very expensive, but we should be putting in three machines to do the work formerly performed by one, so that the first cost of the electric system would be almost three times that of the steam system. Besides, the bill for repairs would certainly be greatly increased by the greater number of machines in operation, so that the electrical system could not be expected to pay for its increased first cost in less than five or six years of constant use. Still, it might be worth installing, regardless of economy in the long run, on account of its other advantages, especially the increased steaming radius at low speeds that would be obtained by saving several tons of coal every day on the auxiliaries.

For a first-rate protected cruiser about 1,600 i. h. p. would be allowed for the auxiliaries. For a battleship, with heavy turret and gun machinery and powerful ammunition hoists, this allowance would be increased to about 2,400 i. h. p.; but, as these allowances are ample for all the auxiliaries, we can safely assume that one half the amounts will supply all the auxiliaries ever in use at one time.

Basing our calculations on 1,200 i. h. p. for the battleship, and allowing the same motor efficiency as above, we find that we shall need dynamos developing 1,014 kilowatts. The naval searchlights now in use require 50 volts. To enable incandescent lights to be supplied from the same dynamos without too much dead resistance

in the searchlight circuit, the electric plants of our naval vessels use a potential of 80 volts, and other navies use an even smaller potential. With 80 volts, then, to develop the necessary power a current of 12,680 amperes is required. At the same time it is impracticable to install on board ship dynamos of more than 1,000 amperes, so that thirteen dynamos would be required to give the necessary power at 80 volts. Any one who knows how crowded the present war-vessels are will at once admit the impossibility of finding room on a battleship for thirteen such dynamos, in addition to the space already occupied by machinery.

On account of the excellent conductor furnished by the hull of a steel ship, and the great number of people who live aboard a man-of-war, grounds on the latter become uncommonly dangerous to life. For this reason no advantages could justify the use of more than 220 volts in a naval plant. Even this might prove fatal to some people; but, assuming that 220 volts may be used safely, and that the difficulties in the way of supplying the lights from the same dynamos can be overcome, we find that five dynamos will suffice, and that one more will bring the reserve up to 30 per cent., which is in accord with present naval practice. The total number of dynamos required would thus be reduced to six, for which room might be found, though with difficulty.

Each one of the six dynamos must be driven by an engine of 360 h. p. Moderate-speed dynamos of the voltage and power thus obtained weigh about 97 pounds per kilowatt, and the compound engines weigh 184 pounds per i. h. p., making the total weight for the six engines and dynamos 524,000 pounds. The navy specifications limit the gross weight of generating sets to one-third of a pound per watt of rated capacity. Such sets are operated by simple engines; but, even admitting that compound engines can be brought down to the same limit, we still have a gross weight of 440,000 pounds. The lowest weight which can be assumed for the motors is 135 pounds per kilowatt. To supply the 2,400 h. p. required for all the auxiliaries, a total weight of 241,650 pounds would be needed, making the weight of engines, dynamos, and motors 681,650 pounds. The present weight of auxiliaries of a first-class battleship can be safely estimated at somewhat more than 100 tons, making the weight of the necessary electrical installation almost exactly three times that of the present steam system. The electric wires would, of course, be lighter than the present steam and exhaust piping, but the saving thus effected would be of no use in comparison, being only about one-third of the weight of the present steam circuit.

The shore engineer may not appreciate how closely the marine en-

gineer and the naval architect must watch their weights. Ship design, especially war-ship design, is a constant struggle to save weight, in order that the war vessel, on a given displacement, may have the speed, protection, and offensive power to enable her to meet and conquer any vessel of her class; and, therewith, the more coal endurance, the better. It will be seen at once, therefore, that any scheme that requires the weight of auxiliaries to be multiplied by three is entirely inadmissible.

There has not yet been sufficient experience with steam turbines to warrant taking the long step of fitting out so extensive and important a part of the ship's machinery entirely with them; and, at the best, their use would reduce the total weight of electric auxiliaries to only about 160 tons,—an amount still too great.

We are driven, therefore, irresistibly, to the conclusion that, although electric auxiliaries offer very many advantages, their great cost and the amount of space they would occupy render a complete installation of them of doubtful benefit, while their great weight makes it absolutely out of the question. It is to be expected, therefore, that the present mixed system of power distribution will continue aboard ship, possibly as long as the steam engine remains the prime mover, but not that electrical appliances will never occupy a more important place there. On the contrary, there is every reason to expect that, with continued progress, both of makers and users of electric machinery, it will gradually be more and more adopted aboard ship for purposes for which it is peculiarly fitted. The necessary power will probably be furnished by a gradual expansion of the present electric-light plant to meet the new demands. What the limit will be depends upon the future improvement in electrical appliances, especially in the matter of weight.

The thanks of the author are due the Bullock Electric Manufacturing Company for data kindly furnished him.

TANK IRRIGATION IN CENTRAL INDIA.

By G. Palmer.

A FORMER article reviewed the general climatic conditions prevailing in the Hyderabad State, the relations of administration to agriculture, and the arrangement of a typical series of tanks. It remains to consider the actual design, construction, and maintenance, of the works, and the revenue derivable from them; and, in this connection, whether or no a tank is one of a series, we may, in considering its method of construction, treat it as a unit by itself.

The method of constructing a tank is extremely simple. It consists in throwing an earthen dam or "bund," as it is usually called, across a valley, the site for the work being selected after due consideration of the following points:

1. Whether the bund will be in such a position as to intercept the drainage of a sufficient area of country to ensure, even in a bad monsoon, the filling of the tank.

2. Whether the general fall of the valley, and the slopes of the sides at the site proposed, are suitable to produce a spread of surface—with a convenient depth of water—that will allow the quantity required to be stored at a reasonable cost.

3. Whether in the valley immediately below the bund, or within such a distance from it as will not entail the construction of unduly long channels, there exists a sufficient area of ground suitable for the production of irrigated crops and for utilising the whole of the water that the tank is capable of storing.

4. Whether the assessment that can be imposed upon the land irrigated will be sufficient, after meeting the expenses of maintaining the tank and its main channels, to pay a fair return on the outlay in constructing the tank.

5. Whether suitable sites can be found, preferably at either or both ends of the bund, for the construction of strong masonry weirs of sufficient length, over which surplus water can flow away after the level of the water in the tank has risen to that of the crests of the weirs, and whether, after passing the weirs, the surplus water can easily be trained back into the natural stream without damaging the bund or injuring the cultivated area.

6. Whether suitable earth can be found in the immediate neighborhood for the construction of the bund, stone for the construction of the weirs and sluices, and good limestone for mortar. The ques-

tion of material is an important one, as means of communication are bad, and many sites are far from main roads, the only means of carriage being the roughly-made, two-wheeled, springless cart of the country, drawn by a pair of small bullocks.

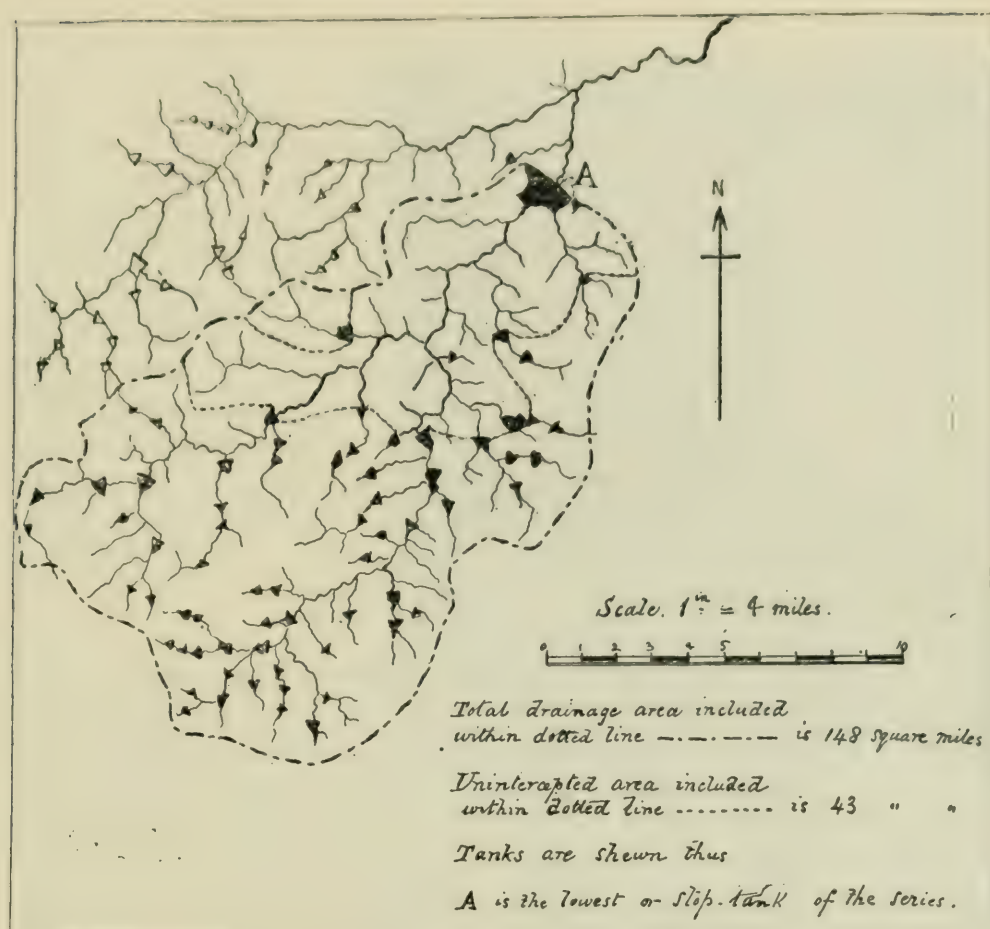
7. Whether the population of the district is sufficient to take up the new cultivation, and whether the people are inclined to do so.

With all the above points duly considered, the ideal bund is that whose length and bulk bear the smallest proportion to the area of the tank formed.

As regards the position of the dam with reference to the drainage area from which the tank will be supplied, and to the cultivable area below (points 1 and 3). This is a question that covers so wide an area that it can be dealt with in practice only by the consideration of each case on its own merits. Thousands of little tanks, or "koontas," were built in olden times by small landholders when the drainage area was below two square miles. It must be remembered that, in a country like the Deccan, where the whole of the available rain-supply falls within four months, where the total annual fall varies considerably, and where the quantity available in any season depends largely upon whether a few heavy falls, such as those exceeding $1\frac{1}{2}$ inches in 24 hours, occur at a suitable time, or whether only light, drizzling rains prevail, a much larger drainage area is necessary to secure a given quantity than would suffice in a country when the fall is more uniformly spread over the whole rainy season, or even over the whole year; and again that irrigation works on the tank system are not constructed with the same regard to the impermeability of the dams, or of the soil on which they stand, that is shown in works designed for a town supply.

As to the proportion of rain that may be expected to flow off the drainage area, the conditions of soil, degrees of slope, and variations in rain-fall, are so numerous that it is difficult to approach a definite rule. A very good authority has given: from .8 of the total fall for mountain slopes or steep rocky hills, to .45 for flat cultivated lands. In the Deccan it is probable that .6 for hilly country to .1 for flat lands may be nearer the mark. The usual allowance is that a cubic yard of water stored will irrigate, including due provision for evaporation and absorption, a square yard of rice cultivation. A drainage area of two square miles may, therefore, with a rainfall of 30 inches in the year, be expected to supply sufficient water to irrigate from 107 to 640 acres of rice, according to the nature of the country. Off some of this area two crops may be obtained in the year, when the total irrigated area will be proportionately reduced.

Tanks with small drainage areas are found only singly and across small tributary streams, or as the top tanks of series. Proceeding



A TYPICAL SYSTEM OF IRRIGATION TANKS.

down a series, we find the next tank at a distance of perhaps a mile, and the drainage area considerably increased beyond that of the tank above, including, as it does, the drainage area of the former, and so on to other tanks across the same stream, until the tributary joins a larger river. See map.

It is difficult also to fix by rule the amount of water that a tank should be constructed to hold. Experience can but propound a rule of thumb, say, that a tank may be constructed to contain $1\frac{1}{2}$ inches of water flowing off each square mile of unintercepted drainage area, and half that quantity for each square mile of intercepted area, sufficient to irrigate, per mile of drainage area, 27 acres in the former case and $13\frac{1}{2}$ acres in the latter.

The lower tanks in a series catch the surplus water from those above, and therefore, till the bottom or stop tank is filled, no water runs quite to waste. Irrigation goes on from the commencement of one monsoon till nearly the commencement of the next. In an ideal season the monsoon months (June to October, inclusive) provide

sufficient rain, collected in and drawn from the tank, for the first, or the "Abi," crop, while at the end of that period the tank is left full to provide for the second, or "Tabi," crop. The most important question in the construction of tanks perhaps is that of the provision of sufficient length of weir to guard against damage to the work from possible excess of flood. This, in the case of an important tank, is no light task. Bye-washes, whereby surplus water can be trained off without flowing into the tank at all, are not in vogue, and their cost in most cases is prohibitive. All the water from the drainage area must flow into the tank, and the surplus must flow over a weir sufficiently wide to prevent the water from topping the earthen bund. The width of weir necessary is easily calculated by ordinary hydraulic formulæ, after deciding what the maximum discharge is likely to be. For this the formula usually employed in the Deccan is that adopted in the Madras presidency by Col. Ryves :

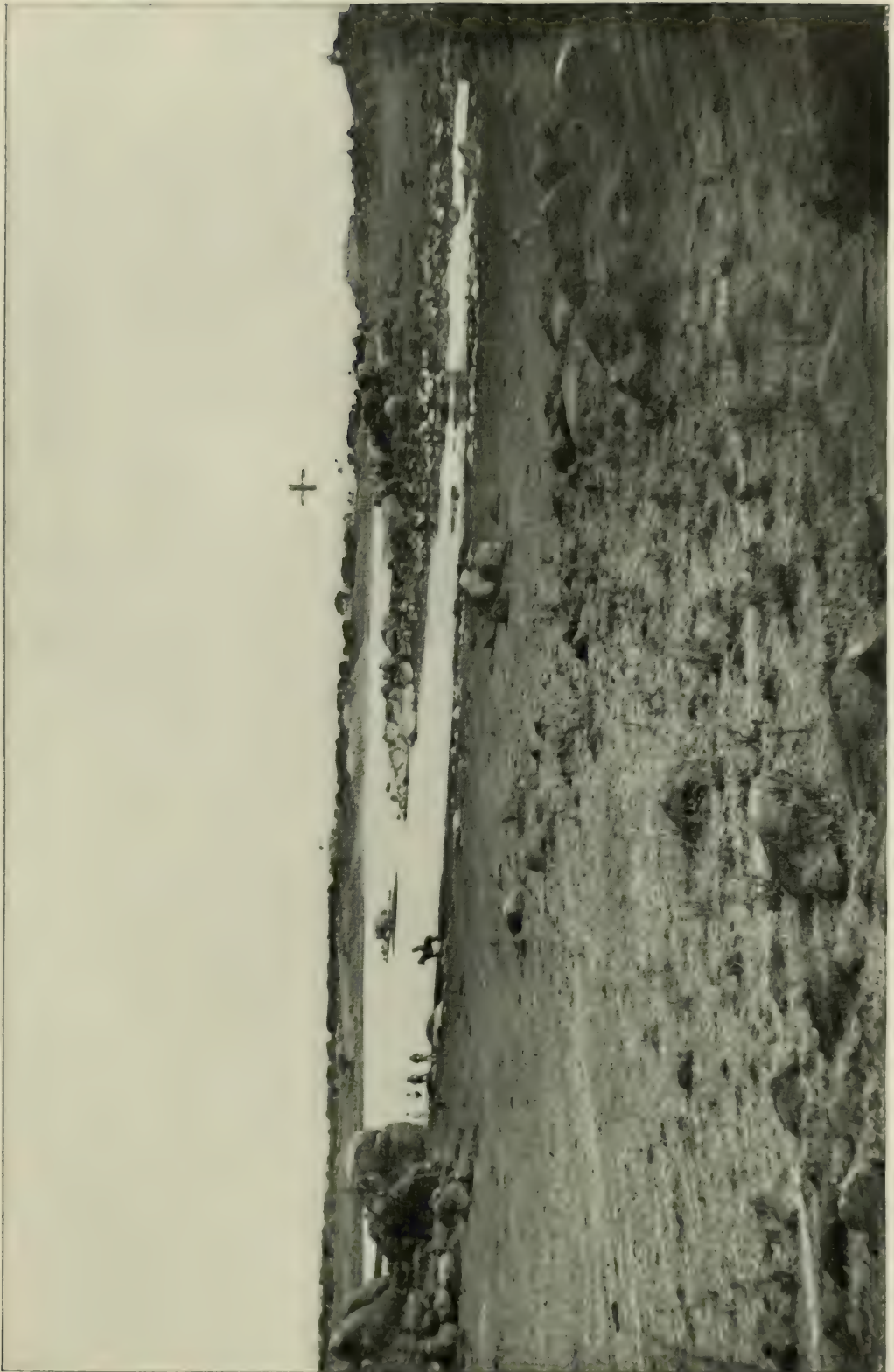
$$D = CM^{\frac{2}{3}} - cm^{\frac{2}{3}}$$

where D is the maximum discharge from the drainage area in cubic feet per second, C is a coefficient varying from 450 to 750, according to the slope of the country, and the amount of rainfall, M is the whole drainage area of the tank in square miles, including the drainage areas of the tanks, above which surplus into the tank, c is a coefficient which may generally be taken as 100, and m is the intercepted drainage area of the tank in square miles,—*i. e.*, the drainage areas of the tanks above.

For country such as mostly prevails in the irrigation districts of Hyderabad, C may usually be taken as 600, except in places near hills where the rainfall is heavy and the gathering rapid, in which case the coefficient should be increased towards 750, according to the discretion of the engineer.

In the case of a tank with a drainage area of 20 square miles, 10 of which are intercepted, this formula would allow for a rainfall of 7.34 inches over the whole area in twenty-four hours, all running off.

The formula may be considered to give the maximum discharge likely ever to take place, from a given drainage area, in cubic feet per second. If applied to each tank in a series, and if the necessary width of weir be adopted in each case, the whole series may be considered as safe from breaching by excess of flood as human forethought can be expected to make it. Occasions arise, however, when the most liberal provision is found insufficient, and it is on record that on two occasions within four years, in the Yelgundul district, heavy falls of rain, of 10 inches in 13 hours and 12 inches



VIEW OF A TANK (JULPULLY), THE BUND BEING UNDER THE CROSS MARK.
The tank, as shown, is partly empty ; when full, the water spreads to the stones in the immediate foreground.



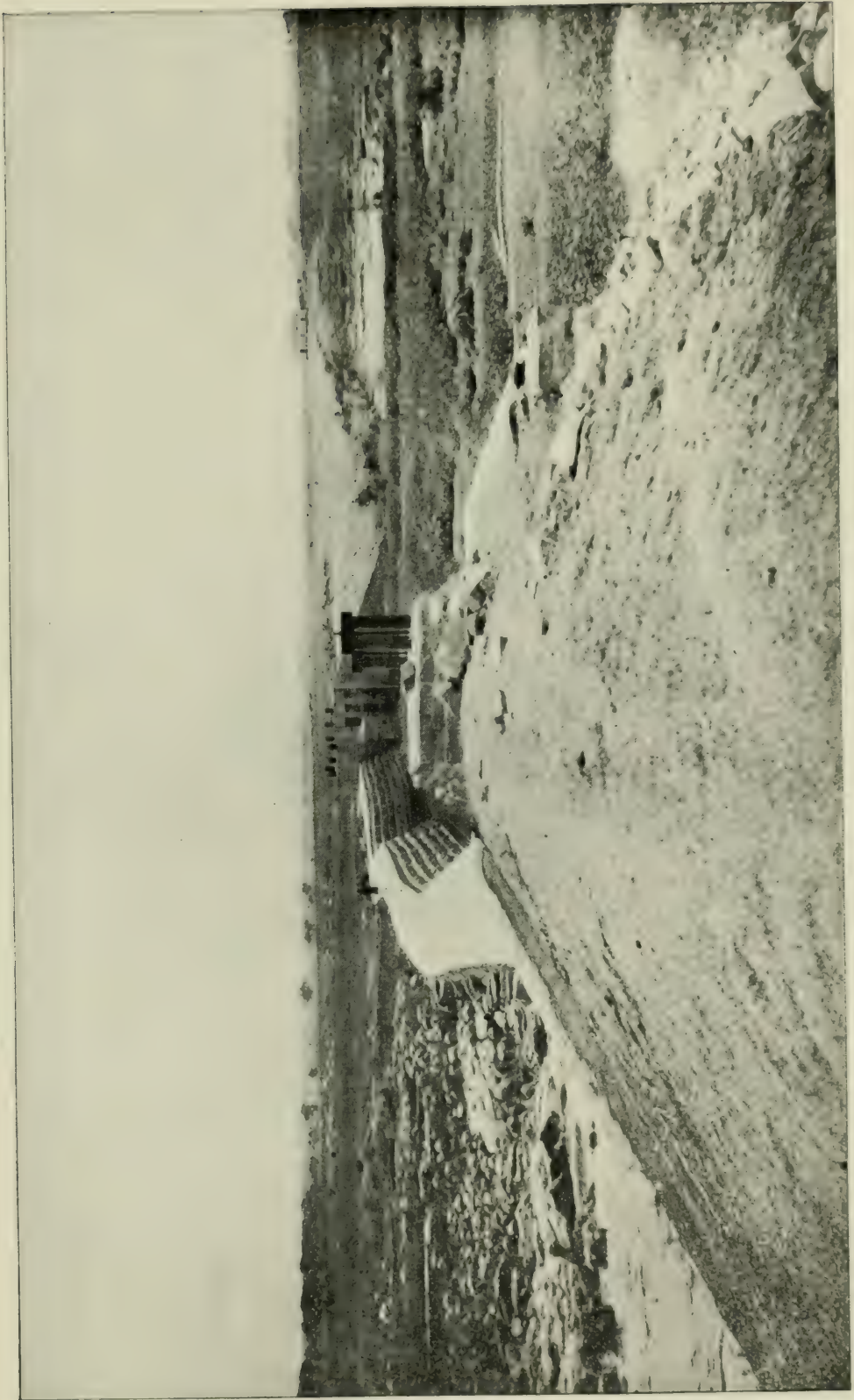
A CALINGULAH, OR ESCAPE WEIR, TO A TANK.

The line is shown by the row of vertical stones. The tank, which is out of sight from this point of view, has a water-spread of about one square mile, an average depth of nine feet, and an intercepted drainage area of about seventy square miles.

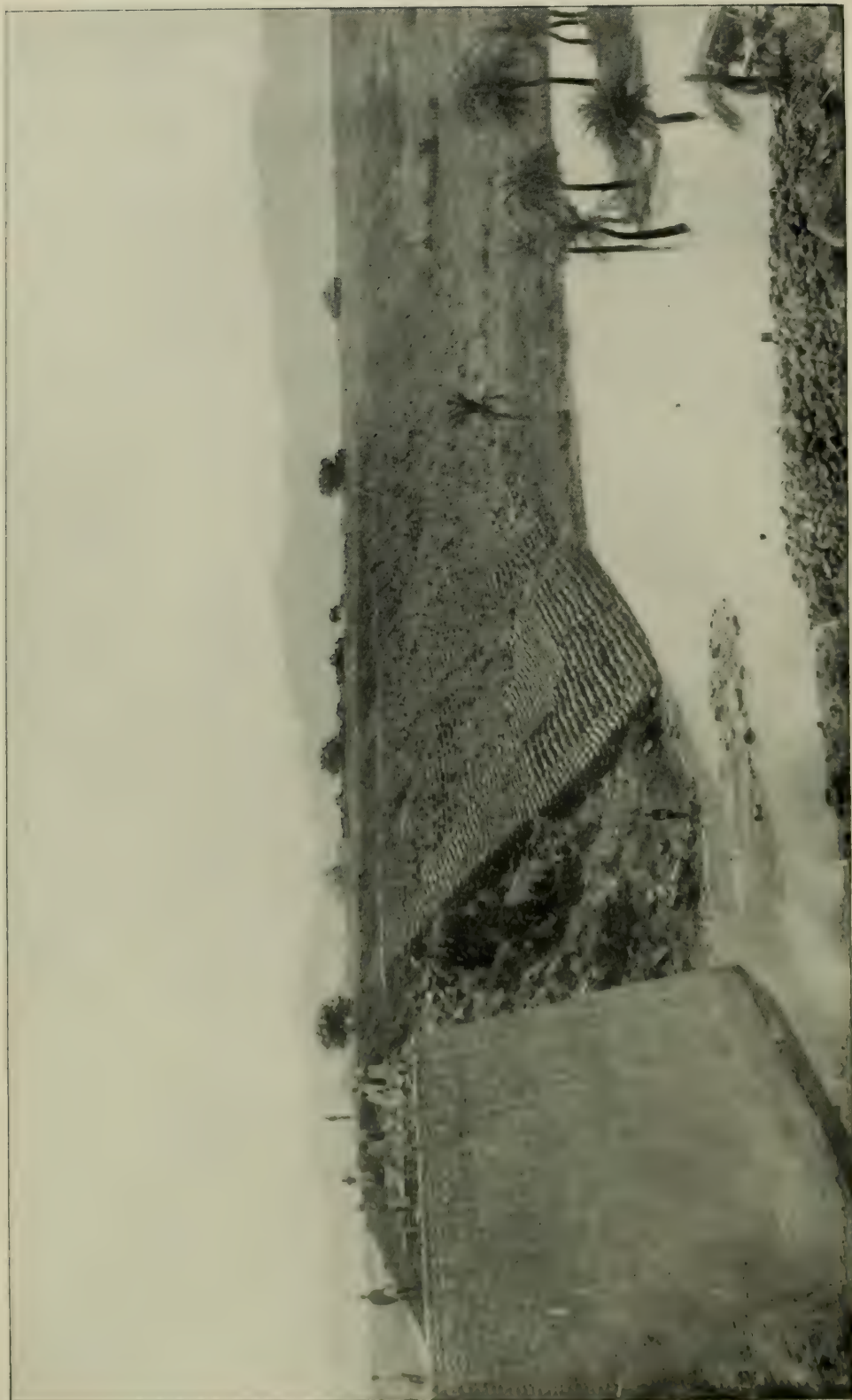
in 11 hours, respectively, occurred, doing immense damage and causing the breaching of nearly 100 tanks in an area of some 1,500 square miles. Many of these tanks, it is true, were not in the best state of repair. It appears, however, that, to resist such a flood as this, each tank bund should be all weir; but the cost of such structures, in view of the revenue derivable, would be considered by the government quite prohibitive.

The weirs, or "calingulahs," as they are called, are usually masonry walls, of sufficient thickness to resist by their weight the pressure of the water against them when flowing at least four feet over the top. The height to which the top of the bund is raised above the crest of the weir should never be less than six feet, though, to save cost, a height of four feet is sometimes adopted in small tanks. In large tanks, commanding, say, more than twenty-five square miles of drainage area, a height of nine feet is advisable. The water must never be allowed to top the bund, and, where the area of water-spread is extensive, the large waves raised by the monsoon winds must be guarded against; hence a height of bund which at first seems excessive proves economical in the long run.

Weirs may be provided with sluices, or openings closed by planks, or shutters of wood or iron of a simple form; in the case of tanks that are constantly under intelligent supervision, the level of the full tank—*i.e.*, the crest of the weir—may by these means be considerably raised. But the majority of tanks are in places where such supervision cannot be had, and where, during the monsoon season, when attention is most required, they are in the charge only of



A DAM, OR ANICUT, ACROSS A RIVER, FOR A SUPPLY CHANNEL TO SEVERAL TANKS. The river runs from right to left of the picture, and is practically dry in the hot season, when the picture was taken. The dam is built on a ridge of rock crossing the river, which accounts for its irregular line.



THE BUND OF AN OLD BREACHED TANK, BEING RESTORED BY BUILDING A MASONRY WALL ACROSS THE BREACH.
The revetment on the bund is 300-400 years old; it was laid with unusual care and regularity.

ignorant native cultivators, who are too anxious to secure an extra supply of water without consideration of risk to the safety of the tank, and who are seldom controlled in this respect by subordinate revenue officers who share this motive.

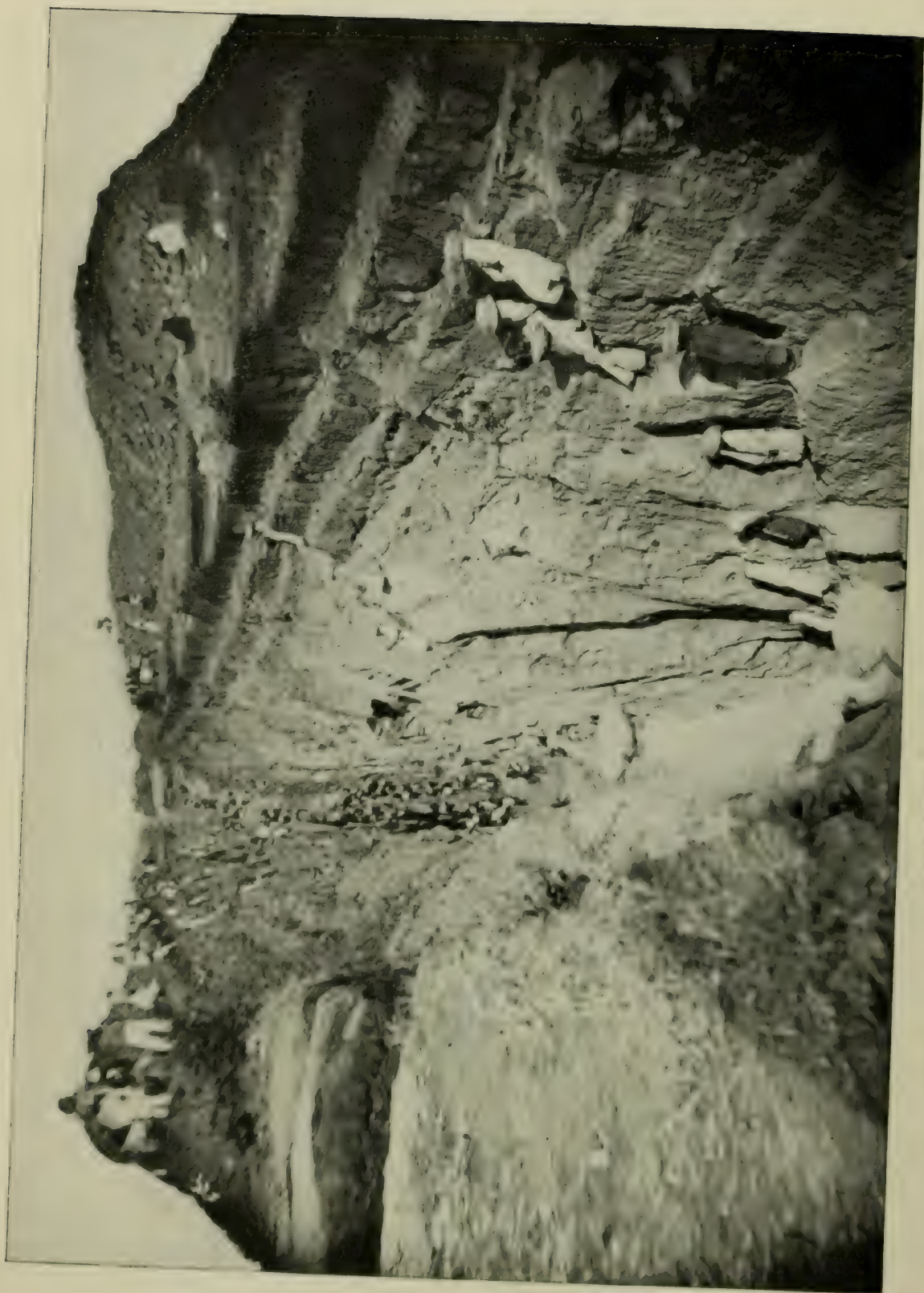
In old tanks it is often found that vertical stones of a height of from two to four feet are placed about three feet apart along the crest of a weir, their object being to enable the cultivators to dam up the water in the tank by means of logs, brushwood, clods, etc., held in place by these posts, to a height beyond that allowed by the solid portion of the weir. This is done towards the end of the monsoon, to retain the water brought in by the last rains; but till the end of November there is no predicting with certainty that a sudden and heavy flood will not come, and the extra dam cannot be moved in time to prevent the bursting of a large and profitable tank. Temporary dams, moreover, even when they have proved successful, are liable to be left till the next season, when the regular monsoon floods may at any time practically demonstrate the risk they cause. Therefore it is advisable to fix the full level of the tank, and build a solid weir with a smooth and level crest to that level, and offer no facility for raising it. The width of the weir is usually calculated to allow a maximum flow of three feet over it. This, when the above-quoted formula is employed, should be sufficient to cope with the heaviest rain-falls, but, with the top of the bund six feet above the crest, there is still a large margin to meet very exceptional floods. The weirs with their wing-walls are usually built of rubble gneiss (a stone very plentiful throughout the irrigation districts), set in good mortar (limestone "kunkur" also abounding).

It is necessary, of course, to choose the site for the weir with reference to the height to which it will have to be built in any part, both on account of cost and on account of the scour of the falling water. To meet the latter, rubble aprons, water-cushions, or ogee falls are adopted.

A weir with its crest not more than one foot above the natural surface of the ground is the most advantageous, if too much excavation is not required in forming sufficient approach for the water.

The bund is usually constructed of the earth found in the locality, specifications always providing that it shall be raised in layers not exceeding one foot in thickness, that clods shall be broken, and that each layer shall be thoroughly well rammed with round-ended wooden rammers before the next layer is imposed.

At the site of the crossing of the natural stream, and when a tank is to be restored by filling old breaches, walls of puddled clay are built in the centre of the dam, of a bottom thickness of six to twelve



EXCAVATING A FEEDER CHANNEL TO A TANK.
Coolies are at work in the bottom of the cutting women, standing on roughly-cut steps to the right, pass up the spoil in small baskets.

feet, according to the height, and tapering up to two or three feet at the top.

Thoroughly impermeable clay, however, is not to be found in the Deccan, and therefore the best material at hand has to be utilised. The slopes of the bund are usually 2 to 1 on each side, increasing to 3 or 4 to 1 when old breaches are filled. It is necessary to protect the water slope to within three feet of the top by well-packed dry stone rubble as revetment, to prevent erosion of the earth-work by waves. The width of the top of the bund should never be less than six feet, a useful rule being to fix it at about twice the square root of the height. Where it is convenient to construct a roadway along the bund, it is an advantage to do so, as the maintenance of the road insures the keeping of the bund to its proper height.

The water is supplied for cultivation through masonry tunnels crossing underneath the bund. It is needless to say that the foundations of these must rest in the natural earth, and not in the made earth of the bund. At the tank end of the tunnel is the sluice-head, which, in the form of a rectangular tower, projects by steps into the tank. The steps are three or four feet high, and each consists of a flat stone with a round hole, six to nine inches in diameter, in its centre. In these holes are fitted wooden plugs, movable by means of wooden rods. The water is allowed to fall into the tunnel through the highest plug-hole covered by the water.

The sluice tunnels are situated according to the levels of the ground to be cultivated. In the best tanks there is one near each end of the bund, to command the highest ground on each side of the valley. Usually one sluice near the middle or deepest part of the bund will supply the low ground in the centre of the valley, when the level of the water in the tank is too low to enable the end sluices to be used. It is a common practice, but one to be strongly condemned, to construct a masonry cistern at the tail end of a tunnel, to allow the water to rise a few feet and thereby command some ground higher than the level of the tunnel admits of. This causes pressure of water inside the tunnel, which, discovering any weak point in the masonry, will produce a leak that may result in serious mischief to the bund.

This necessarily brief article shows a "tank" to be but a primitive form of work, scarcely worthy of a place alongside the well-constructed reservoirs that supply the towns and manufacturing industries of the west, but this primitive form is due, as already indicated, to the conditions of the country, where all such works must be left, for months at a time,—and those the most important months of their utility,—in the hands of ignorant and unskilled cultivators. There is no reason why this state of things should always continue, and, were the govern-

ment to increase expenditure in improving the works, either from government funds or by the encouragement of private enterprise, and were it to appoint an increased and competent establishment of officials under sound professional control, the scope of tank irrigation might be enormously extended, a safe and sure increase of revenue obtained, and the ills of famine and distress greatly reduced. The following figures show the revenue derived by the government from tank irrigation, and the important position it holds in the industries of the State.

The extent of land cultivated, or that on which an assessment is levied, exceeds 14,000,000 acres,—nearly 22,000 square miles. The population, at the census of 1891, was 11,537,040, or $139\frac{1}{2}$ per square mile of the total area of the State, and 522 per square mile of cultivated land. The latest estimated revenue of the country is 30,280,000 Hyderabad or Halli Sicca rupees.

The value of the Hyderabad rupee is about 20 per cent. less than that of the rupee of British India. If the latter be taken as equivalent to 1s. 3d. of English money, the former is worth one shilling. The land revenue may be assumed as representing two-thirds of the total revenue, and as amounting, therefore, to R20,186,666, or £1,009,333 per annum, in which case the average revenue per acre assessed is 1s. 5.3d. Of the total acreage assessed $95\frac{1}{2}$ per cent. may be considered as “dry,” and $4\frac{1}{2}$ per cent. as “wet,” cultivation, but of the total assessment 28 per cent. represents the value of the wet lands against 72 per cent. for the dry.

There are, then, 13,370,000 acres of dry cultivation, realising £726,720, or 1s. 1d. per acre, and 630,000 acres of wet cultivation, realising £282,613, or 9s. per acre.

The outlay by the government in maintaining irrigation works during the last ten years has not exceeded 10 lakhs, or £50,000, per annum. This leaves a balance to revenue of £232,613. It would be very difficult to arrive at the capital value of the works producing this income, as many of them have existed for centuries, and the efforts of the irrigation branch of the public works department in the Hyderabad State, since its establishment some twenty-five years ago, have been devoted more to the restoration and development of old works than to the construction of new; but it may be assumed that money judiciously invested in irrigation works should, with competent management, easily realise from 10 to 15 per cent.

The value of the country as a field for private enterprise depends upon the terms that an individual or a company is able to make with H. H. the Nizam's government. Many political considerations come in. As regards land and water for irrigation works, there is plenty of both for extensive developments.

REVIEW OF THE ENGINEERING PRESS

The Wastefulness of Auxiliary Machinery.

ONE of the most valuable contributions to the literature of marine engineering which has been made for some time is the prize essay of the American Society of Naval Engineers upon the subject of the steam-consumption of the main and auxiliary machinery of the U. S. S. Minneapolis, written by Passed Assistant Engineer W. W. White, U. S. N., and published in the *Journal* of the society.

Since the Minneapolis is one of the latest and finest of the cruisers of the United States navy, it may fairly be assumed that the machinery tested represents the highest state of the art of marine and naval engineering practice, and the completeness of the tests, especially in regard to the hitherto much neglected matter of the auxiliary machinery, renders the paper of especial interest.

The methods employed were such as to include all the steam which passed through the engines, those of the auxiliary machinery being made by condensing all the exhaust steam and weighing the water thus obtained. For the main engines a similar course was followed, except that the condensed steam was measured in tanks; thus the figures give the actual consumption, careful calibrations having made corrections for all leakages properly applicable. Results obtained in this manner must obviously be larger than those deduced from the indicator cards, but, as all the machinery was tested on the same basis, the results are properly comparable, and are also more instructive than might have been the case with computed water rates.

The steam-consumption of the main triple-expansion steam engines was about $20\frac{1}{2}$ pounds per h. p. per hour, which is very fair when it is considered that this includes all the condensed steam which actually passed through the engines, under the conditions of regular sea service.

When we come to compare the per-

formance of the auxiliaries with these figures, we see at once what a jump in consumption there is. The most economical machine in the whole list was one of the circulating pumps, which required 55 pounds of steam per h. p. per hour, while more than one-third of the 31 machines tested showed a steam-consumption of more than 100 pounds per h. p. per hour, and four of these passed the 200-pound mark.

Of course, it must not be forgotten that most of these machines were of small power, from which a high steam economy was not to be expected, but in many cases the causes of the waste could clearly be accounted for on other grounds. Thus, in the case of the dynamo engines, the substitution of snap packing rings for water packing grooves in the pistons reduced the steam-consumption from 123 pounds to 68 pounds per hour, while in the case of a steam pump which showed a steam-consumption of more than 200 pounds, the average stroke was only $7\frac{1}{2}$ inches, when it should have been 10 inches, thus giving an excessive and unnecessary clearance.

Probably nearly all the excessive wastes over and above the necessary steam-consumptions of engines of these small sizes—*i. e.*, from 1 to 30 h. p.—were due to one or more of three causes,—leakage, incomplete strokes causing excessive clearance, and absence of expansion,—while to all of these must be added the fact that the heat from the exhaust of the auxiliaries is not returned to the boilers, but passes into the sea with the circulating water of the condensers.

Not only is the relative steam-consumption of the auxiliaries an unnecessarily large quantity, but the total is a large proportion of the entire consumption of the ship's machinery. Taking the run of the Minneapolis from Gibraltar to League Island, which was seven days in duration, Mr. White estimates the average weight

of steam used by the main engines per hour at 33,621 pounds, and that required for the auxiliaries at 10,147 pounds, or 23 per cent. of the whole; so that the wastes not only are relative, but concern nearly one-fourth of the whole quantity of steam supplied by the boilers.

Several methods have been proposed whereby to reduce these wastes and secure an economy for the auxiliary machinery as high, or nearly so, as that of the main engines. It is hardly possible to do this with a number of small machines, although there is room for much improvement, even with the present general arrangement of auxiliaries. It is probable, however, that some form of central power plant large enough to permit the use of economical multiple-expansion engines, and using hydraulic, pneumatic, or electrical transmission, will be the solution of the problem. Electricity is especially adapted for this purpose, as it would also do away with much of the complicated piping systems now necessary for the conveyance of steam to the small engines; and the experience now available in connection with electrical transmission in stationary plants should make such adaptation to marine and naval practice practicable.

The wastefulness of small auxiliary machinery is not confined to marine service, and doubtless tests of many stationary power-houses would reveal as great wastes as those shown in the tests of the Minneapolis. Efficiency in other directions is now the order of the day, and the turn of economical improvement in auxiliary machinery may now come in more directions than one.

Remodeling Machine Shops.

EVERY one knows how inconvenient and unsatisfactory many old machine shops become as they grow in obedience to the demands of an increasing business, when there is no especial care taken to remodel the plant from time to time and keep it up to date. In many instances a convenient arrangement, and proper operative facilities, make all the difference between profit and loss; and in other

cases leaks and losses are discovered which were previously not even suspected.

An interesting article by Mr. W. S. Rogers, in *Machinery*, gives an account of the remodeling of an old factory, with what is usually somewhat difficult to obtain,—the cost of making the change and the general details adopted.

Of course no two cases are alike in detail, but there is a general family resemblance between old or badly-arranged machine shops, and Mr. Rogers's picture of the establishment before he undertook the reorganization has many points about it familiar to those who have had the opportunity of visiting, or even working in, certain establishments that might be named.

The account of the manner in which wasteful methods were stopped, order created out of chaos, and an economical and modern shop system introduced, shows that all that is required is a fair stock of that most uncommon article known as "common sense," plenty of determination, and some knowledge of what a good machine shop ought to be. Any man who is possessed of these minor qualifications should undoubtedly read Mr. Rogers's article carefully, and then promptly go and do likewise.

One of the most interesting features of the paper is found in the reproduction of two pairs of indicator diagrams, which speak for themselves, and show how much was saved in power by replacing mule pulleys with direct transmission, throwing aside defective old belting, and dispensing with useless pulleys and shafting.

A machine shop may be remodeled in one of two ways,—either by stopping outright, involving a cessation of output, or, less rapidly, by continuing productive work, and changing one portion at a time. The latter method was adopted in the instance described by Mr. Rogers, and the result was a cost of about \$4,000 for time and material, resulting, in one year, in a gain, taken from premiums and time cards, of \$4,348.

"Twelve mule pulleys and 110 feet of shafting were thrown out. The fourth and fifth floors were used for storage of

finished product, being a clear gain of 3,200 square feet. Machines that before required a month to build can now be completed in ten days, easily. Others that required two weeks' time are now completed in one; work in the 42-inch lathe that formerly required six and seven hours is now done in three and four; the high-priced mechanics that formerly spent their time lifting and lugging work from place to place now spend it in fitting and joining things in place; work that formerly had to be sent to and from different floors is now completed right where the machine is built."

"There are hundreds of plants dying of dry rot from the fear of that bugbear, 'awful expense' in making alterations, when the truth is it is like finding money to do it, and the outlay is more than gained in a twelvemonth. It requires determination of the owners to be superior to all others, and a superintendent or engineer without a particle of sentiment, technical twaddle, or fear, but with a cold-blooded idea of the commercial side of his employer's dollars, and who can make both ends meet with nothing in the middle."

The Sweetwater Dam.

THE Sweetwater dam is well known as one of the boldest and most important engineering structures of its kind in the United States, and the manner in which it stood a test far more severe than its projectors ever contemplated renders it of especial interest.

An illustrated account of the high water in 1895, and the manner in which the structure behaved, is given in the *Engineering Record* with illustrations, the article being prepared by Mr. H. N. Savage, the engineer in charge, and therefore coming with an authority which makes it doubly valuable.

The dam is an arched masonry structure of the following dimensions: height, 90 feet; length on top, 396 feet; length on base across stream, 75 feet; thickness at base, 46 feet; thickness on top, 12 feet.

The plan of the dam is an arch upstream, with a radius of curvature of 222

feet on the face line at the top, and is a monolithic structure of uncoursed rubble masonry laid in Portland cement.

The drainage basin above the dam is 186 square miles in area, and, from observations covering a period of ten years, it was concluded that the maximum flow of the stream might possibly reach 1,500 cubic feet per second; so the waste water way was constructed with a capacity of 1,800 cubic feet per second. In the storm of January, 1895, heavy rains, culminating in a fall of 20 inches in 68 consecutive hours, raised the discharge of the stream to 18,150 cubic feet per second, or a little more than ten times the capacity of the waste weir. The river discharged more than 5,000 cubic feet per second for 40 consecutive hours, the dam being over-topped its entire length throughout this time.

While the dam escaped absolutely uninjured, the rocky sides of the cañon at both ends of the structure were badly eroded, several thousand cubic yards of ledge rock being washed away. The 36-inch steel main pipe which extended from the dam down through the cañon was badly wrecked, several thousand feet being entirely undermined and carried away.

The reconstruction work, which was immediately commenced, not only included the repairs to the wing walls, but also provided much greater waste-water capacity. The number of waste weirs was increased, additional pipe-line connections were made, and a basin dam 15 feet in height and 200 feet in length was constructed across the cañon, concentric with the larger dam and 50 feet below, to form a water-cushion in case the main dam should again be overtopped. The ends of the main dam were also carried back further into the cañon sides, to prevent water from getting around them again. As now repaired, the dam is stronger than ever, and, in addition, it has been increased 5 feet in height, adding 25 per cent. to the storage capacity, making the present capacity 22,221 acre-feet, which is equal to 7,240,980,000 gallons.

The fact that the dam itself sustained no injury by this extraordinary test sustains very fully the theory of the constructor,

Mr. James D. Schuyler. The profile of the dam, while theoretically giving stability by its own gravity, has not a large factor of safety, and, when the reservoir is full, the line of pressure not only falls without the middle third, but reaches nearly the centre of the lower third. The nearly perfect character of the foundation, the monolithic arched form of the structure, and the manner in which it was firmly wedged between the rock-bound walls of the cañon, rendered it practically impossible of destruction by rupture or displacement from water-pressure alone.

As an addendum to Mr. Savage's paper, an abstract is given from Mr. Schuyler's account of the original construction of the dam, taken from his paper contributed to the *Transactions of the American Society of Civil Engineers* at the time the dam was completed, in 1888. There is little doubt that the care which was given to the foundation and the masonry work had much to do with the admirable manner in which the dam withstood the emergency, and the work as described shows the value of care and conscientious supervision in so important a matter.

Incidentally, the account shows how difficult it is to estimate the possible maximum flow of a mountain stream, even when observations of many years are available.

Water-Wheel Governors.

IN the use of water power as a source of energy for electric plants the principal obstacle which has been encountered is the difficulty of obtaining that close degree of speed-regulation so essential to the best working of the plant.

An interesting paper upon this subject, read before the electrical section of the Franklin Institute by Mr. Mark A. Replogle, is published in the *Journal of the Franklin Institute*, and some of the points made by him are of undoubted value in connection, not only with the direct subject, but also with the general matter of speed-regulation.

The first point to be considered is the effect of the inertia and momentum of the water, which in long pipe-line transmis-

sions is a very formidable matter, as the case of the Fresno transmission clearly shows. Prompt or sudden changes of flow in such pipe lines are not permissible, if the safety of the installation is a consideration, as the momentum or inertia of the water may cause bursting or collapse, and in some cases the only available method of governing is that of shifting a stream of water on or off the wheel, as power-demands require.

The second factor is the water wheel itself. Its range of speed is from zero to a rate exceeding the spouting velocity due to the head, and it may allow more water to pass through it at under-speed than it does at over-speed, so that an accurate gauging of the water that enters the wheel does not necessarily have anything to do with the speed. The speed of the wheel is the result of quantity of water, combined with pressure on one hand and load of work on the other, and any change in one of these three factors causes a change in the speed. The speed with which the gates are opened or closed affects very materially the action upon the wheel, as a rapid closing causes at first a much greater pressure at the wheel-gate openings, and a consequent increase in the velocity of the water and of the wheel, while a rapid closing produces the opposite effect.

A third factor is the weight of the gates to be operated, as compared with the light valves or cut-off gear of a steam engine. It is a common mistake to underrate the power required for this purpose, and the mechanism for moving the gates of a water wheel is often made too light, and not rigid enough to do the work properly.

The fourth and a very important factor is the action of gravity. The motion which the attraction of gravity has imparted to the water is to be transferred as nearly as possible to the wheel, and, when the load upon the wheel is changed, gravity must have time to adapt itself to the changes which the action of the governing mechanism causes.

The best method of meeting these difficult conditions is to provide a reserve storage capacity by having a sufficiently heavy rotating mass to act as a fly-wheel and sup-

ply or absorb energy in order to allow the change in the load to take place within the desired time-limit and maintain uniform speed within the allowable pre-determined fraction.

"A properly-constructed governor must open the water-wheel gates as fast as gravity can follow up with water—no faster. It must close the gates slow enough to insure safety to the penstocks—no faster. It must be capable of stopping the gates at any degree of opening. It must be endowed with the relay principle, adjusted to coöperate properly with the power storage. It must not be a separate and independent feature of the power plant, but must be made a part of the plant in an intelligent manner, and at best it is only one of the factors in the government of a water-power plant."

"The science of water-power government has not yet reached so great a degree of perfection as the government of steam engines, yet the underlying principles are being carefully studied by engineers, and the time is not far distant when water powers will all be constructed and governed as reliably and successfully as steam plants are; but that time will not come until the same principles are recognized in the former as in the latter."

Building Stones.

IN a recent and valuable paper, read before the mining and metallurgical section of the Franklin Institute, Professor Alexis A. Julien, of Columbia University, discussed the elements of strength in the constitution and structure of building stones, and brought out some points of interest and importance.

Experience has shown that the older methods of testing and selecting stone for building purposes have not been sufficiently satisfactory to be generally relied upon, and the consequence has been a neglect of proper care in this matter, as is evinced by the deplorable results apparent in the speedy injury and mutilation of many great buildings throughout the United States and elsewhere.

Many stones theoretically satisfactory so far as resistance to comprehensive stresses

is concerned are quite unsuitable in other respects.

"The strength of a stone is theoretically its power of resistance, not only to compression, but to all tearing asunder of its particles by forces of frost, weathering, etc. Compressive strength and durability, however, are not synonymous, and their approach in the same stone occurs only in certain kinds, and is then largely modified by climate. Nor does the strength of stone depend to much extent upon its actual mineralogical constitution, though there is need of investigation of many physical characteristics of the common minerals in stone."

The chief elements of strength may be concentrated in four classes:

1. Interlockment of grains, of which three stages occur: irregular aggregation, in helter-skelter disorder and with poor consolidation; parallel sorting of grains; and dove-tailing, or interpenetration. The last is most thoroughly effected in the crystalline stones, and on it far more than on the specific gravities of the constituent minerals depends the weight, taken in mass.

2. Coherence between the grains, effected in two ways. First, cementation, mainly of the fragmental stones, by means of various natural cements, the presence of siliceous cement being the reason for the special excellence of certain sandstones. Second, surface or capillary adhesion between the minute plates and grains, especially in the crystalline rocks. An important distinction must be made between the two classes of voids in a stone, the pores and the cavities, this involving the subject of the different destructive effects of cavities and pores when filled by flakes or films of ice. This question also includes the solubility of stones and their cements in fresh and salt water, upon which there is need of further investigation.

3. Tension among the mineral grains, and the active stresses which survive in stones and affect their strength, of which three classes occur. First, tension produced by crystallization; second, tensions produced by subterranean strain; third,

tensions produced by present physical conditions; all of which may cause a stone to behave very differently from previous specimens examined and tested.

4. Rigidity, or absence of mobility among the grains of a stone. Evidences of internal motion, flexibility, and plasticity in stones may be attributed to three sources. First, cleavage planes of cleavable minerals, particularly mica; second, gliding planes, illustrated by the miniature faults abounding through all varieties of stone; third, the presence of a lubricant, such as oil, bitumen, and especially of water. The influence of water in nearly all stones is most important, and there is need of special methods for determining the strength of wet or moist stones, especially as regards diminution of rigidity from this cause.

Professor Julien's paper will have accomplished much if it only calls attention to the need of some more intelligent methods of selecting stone for building and engineering work, and there should be no real difficulty in establishing proper methods of tests for record and specification purposes, when once the fundamental lines of the work are clearly marked out.

Mining Claims in River Beds.

IN view of the various propositions, broached of late, to dredge streams in gold-bearing regions, material interest attaches to a communication from Dr. R. W. Raymond in the *Engineering and Mining Journal* upon the law as to dredging rivers for gold, this question until now not having come up for adjudication, and there being in consequence no direct precedents.

Starting out with the fundamental propositions that in the United States navigable rivers within a State belong to the State, and that other rivers belong to the United States, Dr. Raymond proceeds:

"The operation of dredging for gold may or may not injure a navigable river, or impede its navigation. If it does neither, I do not see why it may not be freely carried on, so long as the State does not interfere, but subject to the State's in-

terference at any time. Some of the States, I may add, have laws already concerning the mining of river-beds; and all the rest of them would make such laws very promptly, if circumstances should call for them.

"It would be, consequently, an act of folly to commence operations of this kind without some direct authority protecting the enterprise.

"With regard to a stream not navigable, it is a simple question whether that part of its bed is or is not on the public domain. If it is, it can be freely explored by citizens of the United States, and it can be appropriated in placer claims of not more than 20 acres for each individual claimant. An adventurer might 'explore' up and down a river to any extent by dredging, without having made any location, so long as no one else stepped in to make a location. But he could have no rights against a locator; and therefore the only safe basis for his enterprise would be the naming of a regular placer location, within which his operations might have to be ultimately confined.

"Grounds not on the public domain can only be occupied for this purpose by agreement with the State or the private owner. And in no case can the prior rights of a riparian owner, adjacent, above or below, be interfered with. For navigable rivers, navigation is the supreme use; for all others, the supreme use is agriculture."

Steel and Concrete Construction.

THE use of combinations of steel and concrete for arches and similar constructions is well known; and on both sides of the Atlantic the systems of Monier and of Melan have been used and tested.

The results have been sufficiently satisfactory to render desirable the wider application of the principle of combining two widely-different materials into one structure to resist opposing stresses; hence the paper of Mr. George Hill upon "Steel Concrete Construction," presented before the American Society of Civil Engineers, and published in the *Proceedings*, is especially opportune.

This paper treats of a series of tests of

flat slabs of concrete and steel, in which the steel acts entirely in tension, being distributed through the bottom section of the slab, this construction being especially useful in filling between rolled floor beams in steel-building construction. A fire-proof combination requiring no arches between beams is thus obtained, and the use of the steel secures a degree of strength amply sufficient for the loads which the floors are called upon to bear.

The steel used in the experiments was in the well-known form of expanded metal, made from high-grade low-carbon bessemer steel, containing 0.008 carbon, and showing a tensile strength of about 65,000 pounds and an elastic limit of 30,000 pounds. The cements were an American Portland and a slag cement, both stone and cinder concretes being tested for spans ranging from 60 to 120 inches.

"Theoretically, the best results are to be obtained from any combination of this character where the entire compression is taken by the concrete, and where the metal employed is so placed as to occupy the position of the extreme fibre on the tension side.

"Theoretically, it is also necessary, in order to develop the full strength of the metal, that it should be held in place by some means possessing greater strength than simple cohesion between the concrete and the steel. The difficulties to be encountered, in making any series of tests for the purpose of determining the laws governing the resistance of such combinations, were known by the fact that no formula had ever been suggested which even approximately accounted for the extremely high resistance of sections put in place in buildings and tested under concentrated loads."

"In building the slabs, the expanded metal was usually put down in single sheets, with the long axis of the mesh at right angles to the beams, and so set as to be well covered by the concrete in the bottom of the slab. The sheets were sometimes lapped and sometimes doubled, and, when this was done, the only tying was that afforded by the concrete."

The testing machine was arranged so as

to apply a load upon a piece of yellow pine 3 feet long, 1 foot wide, and 3 inches thick, placed in the centre of the slab, the reaction of the plunger being opposed by two cast-steel wire-rope straps passing around cross beams which ran underneath the supporting beams.

Sixty different tests were made, using different mixtures of concrete and various spans and thicknesses of slabs, the results being very fully tabulated; for this detailed information reference must be had to the original paper, but from these data Mr. Hill has deduced formulæ from which computations for similar slabs may be made.

Making due allowance for the lack of uniformity of some of the tests, the conclusions were that for a fairly well mixed cinder concrete the ultimate compressive strength should be about 400 pounds per square inch, and for a stone or gravel concrete at least 800 pounds per square inch, the tensile strength being taken at one-fifth the compressive resistance. Taking into account the deflections observed in the tests, the author uses as his constants, for safe working stresses of cinder concrete in compression, 75 pounds per square inch, and, for stone concrete in compression, 150 pounds per square inch, which corresponds to a deflection under uniformly-distributed loads of about one-quarter of that required to crack plaster, and to strains of about one-fifth of the elastic limit of the concrete.

As a result of computations from Mr. Hill's formulæ, a table is given of the proper thicknesses of steel-concrete slabs for live loads from 75 to 250 pounds per square foot, from which it appears that for a span of 10 feet a thickness of concrete of 5 inches corresponds to the above stress-limits with a live load of 75 pounds per square foot, while, for a live load of 125 pounds per square foot, a thickness of 7 inches is necessary to insure the same stresses. By the use of these tables, observing the same conditions as to quality of cement and methods of mixing, floor slabs of steel-concrete may be planned with a fair degree of assurance as to the actual margin of safety which will exist for the corresponding loads.

The Analysis of Furnace Gases.

IN determining the efficiency and nature of the combustion which takes place in boiler and other furnaces it has long been recognized that much could be learned from analyses of the discharged gases as they pass through the flue on their way to the chimney. Usually such analyses are made in the chemical laboratory from samples of gas drawn from the flue by water-suction or by a pump, but it is often difficult to be certain that an average sample has been secured, or that all the conditions of average working existed at the time the gas was drawn off.

These defects can best be remedied, and much additional information obtained, by the use of some form of continuous recording apparatus which may at any time be consulted to ascertain the relative proportion of the principal constituents of the discharged products.

One piece of apparatus for continuous examination of furnace gases is the Arndt "Economometer," a full description of which is given in the *Journal of the Franklin Institute*, in connection with the report of the committee on science and the arts. This apparatus continuously weighs the flue gases, the fluctuations in weight indicating the proportion of carbonic acid gas present, from which the efficiency and character of the combustion may simply and readily be deduced.

This weighing of gases is effected in a gas vessel suspended at one end of a balance beam and carefully counter-balanced in such a manner that any change in the weight of the gaseous contents will disturb the equilibrium. The gas vessel is open at the bottom, and a continuous flow of furnace gases passes through, after having been filtered through cotton and dried by calcium chloride. Since carbonic acid is about one-half heavier than air, and since the other constituents, mainly oxygen, nitrogen, and carbonic oxide, approximate the specific gravity of air, it is possible to graduate the pointer of the balance so that it will indicate the percentage of carbonic acid present.

The econometer, however, is not a recording device, but may be compared,

rather, to a steam gauge, indicating to the eye the passing variations in the composition of the furnace gases. For recording the composition, including more than one constituent, if so desired, a device known as the Uehling and Steinbart "Composimeter" has been made. This operates upon a different principle from that of weighing, the various gases being absorbed by suitable chemicals and the suction caused by the absorption being used as a measure of the proportion of carbonic acid or other gas present. The measure is the reduction in volume of gases which takes place in a chamber in which two apertures form respectively the inlet and outlet, and through which the gas is drawn by a constant suction. If, from the stream of gas flowing through this chamber, one of the constituents is continuously removed by absorption (such as carbonic acid by caustic alkali), a reduction of volume takes place in the chamber, which causes a corresponding change of suction that acts upon a suitable recording gauge. There seems to be little doubt that the general use of such devices as the econometer or the composimeter will contribute materially toward a general improvement in the performance of coal-burning apparatus, since a defect which can be located is well on the way to be remedied, and nothing so much contributes to the efficiency of employees as an automatic, mechanical record of the results of their work.

Nelson W. Perry.

THE death of Mr. Nelson W. Perry, which has been referred to with feeling throughout the technical press, touches this magazine closely on account of his long and close relation as contributor and adviser. Mr. Perry was a graduate of Columbia School of Mines, a member of the Institute of Mining Engineers and the American Society of Mechanical Engineers and of the Chemical Societies of Berlin and Paris. Latterly he devoted his attention to electricity, and was editorially connected with *Electricity* and the *Electrical World*.

THE ENGINEERING MAGAZINE joins the many friends who mourn his loss.

THE BRITISH PRESS

Technical Education.

THE remarks of Professor Ayrton at the time of the awarding of prizes at the Coventry Technical Institute, published in the *Electrical Engineer*, contain words so wise and important that, in spite of the well-worn condition of the subject, we feel that a repetition here will be acceptable. Speaking as he did at a technical school, reference to manual training was inevitable, and Professor Ayrton made some points not usually heard on such occasions. Instead of a technical training becoming too practical, as many have feared, he thinks there is a risk of its becoming too theoretical. When a technical teacher has to spend the greater part of his time in giving out information, he has but little left to take any in, and he thereby runs the risk of losing touch with his trade or profession. His so-called practical teaching may then easily become unpractical and untechnical, academic, stereotyped, and only distantly related to industry.

In regard to the use of machinery and the too-common feeling among workmen that labour-saving tools are an injury to the manual workman, Professor Ayrton spoke of the fallacy of such views, and said that the feeling prevalent at the beginning of the century, and still held by many, is the misguided notion that the amount of work to be done in the world is a fixed quantity, instead of varying with the demand and supply, and, therefore, that it ought to be parcelled out like food among a shipwrecked crew.

The mere fact that wages are highest and the standard of comfort in living best in those places where the most efficient and most highly-organised machinery is in use is a sufficient refutation of this mistaken position.

It is refreshing, also, to hear outspoken utterance about the minor importance of prizes and set examinations.

"We all like to come out well in examinations, to be awarded prizes, and to win

the approbation of our relations and friends. And this desire to stand high in the examination list undoubtedly furnishes a keen incentive to many young people to work hard. It should be, however, a consolation to those who do not shine in the examination room, but who yet feel that they have got something in them, to remember that success in life is not attained by supplying written answers to a series of questions."

It was Dr. Oliver Wendell Holmes, we believe, who remarked that he did not believe that there was a member of the faculty of Harvard University who could pass the admittance examination to the freshman class without previous preparation; and Professor Ayrton practically admits the same thing when he says that he frequently sets himself a question and then gives himself but a low mark for the inadequate character of the answer which he is able to give, and that, too, in the subject which is his chosen specialty and upon which he is considered an authority.

It is easy to test the ability of the student to give written answers to set questions upon definite subjects. "But it is far less easy for an examiner to assign marks for a student's force of character, for his power to overcome previously-unforeseen difficulties, for his coolness under trying conditions, for his quickness in observing a small effect on which large issues may depend, for his good presence and power of impressing his fellow-men, etc. And yet all these qualities are of enormous value in real life.

"The moral then seems to be for the methods taught at a technical school to be kept well up to date, and for its students to do their best to excel in them, ever striving to increase their stock of those all important characteristics—alertness, thoroughness, and truthfulness—not merely in word, but also in work at the bench, the forge, and the vise,—the truthfulness which is the slayer of shoddyism."

Photo-Surveying.

THE use of the photographic camera as a surveying instrument is by no means new, and is, indeed, the natural outgrowth of the applications of its predecessor, the camera-obscura, in similar lines of work. It has taken the gradual improvement in lens construction, as well as the application of suitable auxiliary apparatus, to make the photographic surveying camera an instrument of sufficient precision to rank with the level and the transit, but now, especially for preliminary and exploration work, the photographic method must be accepted as possessing many advantages.

A paper upon the subject recently read before the Institution of Engineers and Shipbuilders, in Scotland, by Professor E. J. Mills, gives the present status of the method, with descriptions of the latest forms of instruments, and some interesting examples of their application.

The earliest work done in this way was probably that of Laussedat, who completed a photographic survey of Paris in 1861, followed by others in Grenoble and in Savoy; the latter, completed in 1867, extended over 21·2 square miles, with a very considerable range in height. Similar work has been done in Germany, Italy, and Austria, but the most extensive photographic surveys have been made in Canada.

"In 1892 an international commission was appointed to examine the boundary between Canada and the United States territory of Alaska. Mr. W. F. King, the Canadian commissioner, carried out his share of the work photographically; and it is stated that in 1893-94 his parties surveyed about 14,000 square miles. Mr. E. Deville, the present surveyor of Dominion lands, has done much work of this kind in the Rocky mountains. Surveyors are under a considerable debt to him for his very able treatises (1889, 1895) on the subject. Deville finds the cost of the camera method to be about one-third of that used in ordinary surveying, and adds: 'Properly used, it gives results far beyond what can be accomplished by any other process.'

"Since the time of Laussedat's early

work, the improvements in apparatus have chiefly been matters of detail. Rectilinear lenses and backed gelatine plates are now always employed, and, for a distant work, isochromatic plates. Even very distant objects can now be brought under examination by means of the telephoto lenses of Dallmeyer and others. Indeed, a modern photo-theodolite possesses every essential of an excellent surveying instrument, with a range of work more extensive than is possessed by any of them."

Professor Mills describes a surveying camera of his own pattern, which practically includes all the essential features for accurate work. The centre of the lens is directly over the axis of the graduated horizontal circle, and a scale and vernier provided, by which the actual focus at any adjustment can be measured. Four teeth are so placed in the back as to mark points upon each negative indicating vertical and horizontal lines passing through the optical centre of the lens, while a graduated ground glass enables the relative positions of points to be seen. Levels are provided, and a compass to assist in placing the instrument. A camera thus equipped is capable of very accurately measuring both horizontal and vertical angles, the tangents of which can be easily obtained by dividing the ground-glass readings by the actual focal length.

The general principles of the method are not different from those used in ordinary angular surveying, except that the measurements are made upon two negatives, or prints, taken from two previously-determined points, and that the laws of perspective must be followed in making the measurements. All computations are, of course, dependent upon the actual focal distance between the centre of the lens and the surface of the negative; hence it is important that this distance should be accurately measured for each focus. Usually a base line is measured, and the camera set up at one end and adjusted to cover at centre a signal at the other station. The circle is then rotated until some well-defined object appears at the centre. The angle of rotation is read off, and a photograph taken "at point." The camera is

then set up at the other end of the base line, and the angle to the same point is observed; here also a photograph is taken. From the negatives thus obtained bromide prints are made, and, if amidol developer is used and the prints are soaked in a 2-per cent. solution of formalin, and dried at a gentle heat, there will not be enough shrinkage to affect the accuracy of the measurements appreciably.

The accuracy of the method may be gathered from the statement that two independent measurements of the height of the flagstaff at Doune Castle above the centre of the lens differed only by about two inches.

An ingenious suggestion is made as to the use of profiles made by this method for earthwork computations. Two contiguous profiles may easily be cut out in cardboard or tin, and set upright against a rectangular background. The interspace may then be filled with clay, or some other plastic material, and this dressed to shape, after which the clay may be transferred to a measuring vessel and its bulk in cubic feet determined. The result multiplied by the cube of the inverse of the scale of the photograph will give the number of cubic feet to be excavated.

Parabolic Reflectors.

IN a paper before the Institution of Electrical Engineers, published in the *Electrical Engineer*, Mr. Sherard Cowper-Coles describes an electrolytic process for the manufacture of parabolic reflectors, which seems likely to come into extensive practical use. At the present time glass mirrors are almost exclusively used for search-light projectors, but the objections to glass, such as weight, fragility, and injury from heat, have led to various attempts to make parabolic mirrors of metal. Spun mirrors are never true, however, and stamped ones have also failed to give satisfaction, while the cost of cast and polished reflectors has prevented their general adoption.

Mr. Cowper-Coles proposes a method which seems free from the objections previously found. It involves the cost of producing a single glass mould which

shall be true, after which this true parabolic shape can be reproduced indefinitely at a nominal cost, the surface requiring no after-polishing or truing up.

The glass mould is formed to a true parabolic figure on the outside, and highly polished. On this prepared surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished, so as to ensure the adherence of the copper backing. "The mould thus prepared is placed in a suitable ring and frame, and immersed in an electrolyte of copper, the mould being rotated in a horizontal position, the number of revolutions being about fifteen per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature to 120° F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent tarnishing. Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness; the palladium resists tarnishing and the heat of the arc to a wonderful degree."

The details of the method are very clearly indicated in the original paper, with sketches of the apparatus and practical hints as to the precautions necessary in order to obtain satisfactory results.

Reflectors made in this way have been tested very thoroughly, and found to stand excessive heat without tarnishing. Salt water has been thrown upon them while hot, the water being driven off as steam and a white deposit left on the reflector, which was easily wiped off with a wet cloth.

A feature of the metallic reflector of especial value in military signalling operations is that it cannot be destroyed by

bullets. A reflector recently tested at Portsmouth was perforated by a number of rifle bullets without other injury than the small reduction in the area of the reflecting surface, the beam of light being little affected. A single bullet splinters a glass reflector.

In view of the rapidly-extending use of electric signalling apparatus and the employment of parabolic reflectors in search-light apparatus, this improved method of making accurate and durable mirrors at a commercially satisfactory cost, besides possessing all the advantages of metal over glass, must be regarded as a valuable contribution of applied science to manufactures.

Since the appearance of Mr. Cowper-Coles's paper, Professor Elihu Thomson calls attention to the fact that he made mirrors in identically the same manner many years ago, but in view of the fact that no publicity was given to the process and that Mr. Cowper-Coles undoubtedly re-discovered it in ignorance of the previous work of Professor Thomson, the former is entitled to full credit for the public introduction of the method.

Gas-Engine Research.

ONE of the signs of the increasing interest in the improvement of the gas engine is the fact that a special committee on gas-engine research has been appointed by the Institution of Mechanical Engineers, and the first report of this committee, presented at the recent meeting of the institution by Professor Burstall, and printed in the *Journal of Gas Lighting*, shows evidence of good work.

The plan under which the tests were made consisted in making successive variations in speed, compression, and gas mixture, endeavoring to keep all other conditions as nearly constant as possible, in order that the effects of any given change could be traced to the true cause. By using a special experimental engine, in which special provision had been made for these points, some important and valuable information was obtained.

One question about which much interest is expressed at the present time is the

influence which increased compression really has upon the economical working. It is usually assumed that a high economy necessarily results from a high compression, and a large portion of the claim in the matter of economy made for the latest comer into the field of internal combustion motors is based upon the very high compression pressure used. At the same time attempts to increase the compression in some existing engines have not acted to increase the efficiency, but have even caused a diminished economy, and there has been some difference of opinion as to the real relation between compression and economy.

In Professor Burstall's tests there appeared a relation between the mixture of air and gas and the most efficient degree of compression, and it seems probable that the influence of increased compression on economy is due to the fact that weaker charges can be burned completely during the stroke when the compression is high. This quite agrees with the experience of Diesel, who says: "The temperature of ignition is a constant value, and only dependent on the physical qualities of the fuel. It is very low for most fuels, and, the higher the pressure at which ignition is effected, the lower the temperature. On the other hand, the temperature of combustion is a variable value, being dependent on many conditions, especially on the quality of air by which the combustion is maintained, and which, under all circumstances, is higher than the temperature of ignition."

The small engine used in these tests gave a rather low efficiency in all cases, but the economy was distinctly raised by increase of compression, the efficiency being only 12.6 per cent. for a compression of 52 pounds absolute, and reaching 18 per cent. with a compression of 105 pounds.

Several interesting features were brought out in the discussion, especially in connection with the serious action of otherwise minor influences when so small a motor was used for the tests.

Mr. Dugald Clerk showed that the leakage past the indicator piston was sufficient

to affect the result materially. In an engine of this size, with cylinder 6 inches bore by 12 inches stroke, the turning on the indicator to take a card often caused a considerable falling off in speed, while a timing valve in connection with an ignition tube was very severe in its effect. These facts must qualify the conclusions to be drawn from tests with very small engines in extending the reasoning to larger motors. The difference between the leakage by the indicator in a gas engine is very different than with a steam engine. In the former case the mixed gases are leaking away all the time during the compression, before the ignition has occurred, thus rendering the combustion different from what had been intended.

So far as the tests have been conducted, the principal conclusion is that economy depends upon the choice of the correct ratio of air to gas, and that this ratio increases with the compression. The number of experiments is not yet sufficient to determine what this ratio is for any given compression, but further trials are to be made to determine this important point.

The Education of Miners.

As a part of the general interest in technical education aroused of late in connection with the development of foreign competition, the necessity of a higher degree of scientific training for mine workers was discussed by Professor Henry Louis at the recent general meeting of the Federated Institution of Mining Engineers at Newcastle-on-Tyne. The paper contained some points of much value, and drew forth an animated discussion, which in itself should do much to further the cause of better technical training for miners.

Professor Louis drew a distinction between the technical education suitable for a mining engineer, general manager, or viewer, and that suitable for the working miner. The working miner's education should be such as to enable him to rise successively to the positions of subordinate official, under manager, resident manager, and mine captain.

Taking the working miner in England, he should possess at least the rudiments

of a good English education before beginning his technical instruction, either on the surface or underground. After his practical training has begun, he should continue his studies in evening classes, extending his knowledge in mathematics, acquiring the rudiments of applied science and mechanics, and finally devoting a considerable portion of two or three years to the theory of mining. With the practical knowledge of mining acquired in his daily work underground, by the time he attains the age of twenty-two or twenty-three he should be ready for his second-class certificate.

"There is scarcely any mining district in Great Britain in which tuition in the subjects comprised in the above outline scheme cannot be obtained; a rather greater difficulty is to be found in the question of examinations. Throughout the mining districts of the country a fair and steadily increasing number of young men is to be found, anxious to take advantage of the educational facilities offered to them.

"But, above all, the point which the writer has more than once had occasion to urge must once again be repeated and emphasised,—that the better education of the working miner is the best possible safeguard against accidents. Fully two-thirds of the annual roll of accidents are preventable, and preventable by the training of the miner in thinking power and in the elementary principles of science. Let it not be thought that too much emphasis is being laid upon the importance of the scientific education of the working miner; the level of technical education needs raising, and it cannot be raised unless all ranks advance proportionately."

Referring to the training of the mining engineer, Professor Louis remarks that, in view of the fact that custom has decided in Great Britain that three years is ample for the scientific training of the mining engineer, the aspirant will have to come to his work exceptionally well prepared.

The necessity for use of the three short years to the best advantage was fully discussed, and the coal mines regulation act criticised as giving too much weight to

time spent about the mine in comparison with that used in acquiring the scientific portion of a mining training.

In view of the criticisms which Professor Louis makes upon the present system, his proposed remedy is of interest. The chief reforms he advocates are the following:

(1) Every manager of a mine, whether coal or metalliferous, to hold a certificate.

(2) Certificates to be granted upon examinations controlled by a central board, making the examination identical in conditions and character for the whole of Great Britain (and, if possible, for the colonies also).

(3) A minimum of scientific training to be insisted on, and residence in a recognised scientific college to count up to, say, one-half of the apprenticeship required. At the same time a minimum of underground training to be also insisted on,—say, three years for each example.

(4) Every mine surveyor to hold a certificate of proficiency.

Professor Louis ventures to think that these suggestions are neither very drastic or very revolutionary, and is convinced that much good would result from their adoption.

The Central London Railway.

THE account in recent issues of *Engineering* concerning the plans for the Central London Railway gives a very excellent description of this important piece of rapid-transit work, and, although the data are in some respects only preliminary, and fuller details are reserved for later publication, a very fair idea of the magnitude and character of the undertaking is obtained.

Owing to the exaggerated valuation placed upon proprietary rights, it was decided to follow the line of public highways, instead of running the tunnel under private property; and the line adopted runs from the Bank along Cheapside, Holborn, Oxford street, Bayswater road, and Uxbridge road, to Shepherd's Bush,—a total distance of about $6\frac{1}{2}$ miles.

The compact bed of clay upon which London is built makes the engineering

work of construction comparatively simple, as the boring can be done continuously by use of the Greathead shield, and the completed tunnel lined with cast iron without any disturbance of the upper soil.

The railway will be constructed with two separate tunnels, driven through the clay beneath all pipes, sewers, and other underground work, each tunnel being 11 feet 6 inches in diameter.

The plans provide for trains at $2\frac{1}{2}$ -minute intervals, each train consisting of 7 carriages drawn by an electric locomotive and furnishing accommodations for 336 passengers. The full meaning of this will be appreciated when it is remembered that the present train-interval on the Inner Circle is from 5 to 10 minutes.

It is possible here to give only a very general idea of the electrical and mechanical features of the plant; for detailed particulars reference must be had to the longer descriptive articles. The current will be generated in three-phase machines and will pass through rotary converters and drop-down transformers at sub-stations. It will be generated at a pressure of 5,000 volts, and transformed and converted into a direct current of 500 volts before it enters the lines.

The locomotives, of 45 tons' weight, will be similar in appearance to those made for the Baltimore Belt Line of the Baltimore & Ohio Railway, the current being delivered by a third rail and transmitted by a slipper to the locomotive. The distribution of the work was very carefully plotted in diagrams, in order to ascertain the probable demands on the motive power, the closeness of the stations and the high speed between them causing great changes in acceleration and retardation. These inequalities will be partially met by placing each station on a summit, so that the entering trains are retarded and the outgoing trains accelerated by gravity. These resistances, as well as those due to the atmosphere and to friction, are included in the diagrams, and the average power required is thus computed.

The power house is planned to contain

six Reynolds-Corliss cross-compound condensing engines, each coupled direct to one 850-kilowatt three-phase generator. The engines are to run at 94 revolutions per minute, and are 24 and 46 inches bore by 48 inches stroke, indicating 1,300 h. p. The engines are guaranteed for a consumption of $13\frac{1}{2}$ pounds of steam at 1,000 h. p., and the speed variation is not to exceed $1\frac{3}{4}$ per cent. between minimum and maximum load.

The boiler house is to contain sixteen Babcock & Wilcox boilers, fitted with Vicar's mechanical stokers. Coal being fed by mechanical conveyors from overhead bins, and ashes being removed in a similar manner, the manual labour is reduced to a minimum. Four Barnard cooling towers provide for the removal of the heat from the condensing water, each tower being 14 feet $8\frac{1}{2}$ inches in diameter and 50 feet high—this being by far the largest installation of evaporative condensers in England.

The operations of the road involves also the construction of numerous lifts at the various stations, and an elaborate system of oval subway construction at the Mansion House, which will not only afford easy and convenient access to the City terminus, but also be of much use in facilitating crossing at this crowded spot.

At the present rate of progress it is estimated that about a year will elapse before the road can be opened to the public, but, when completed, one will be able to make the full distance in twenty-five minutes, or go from Oxford Circus to the bank in ten minutes.

The engineering has necessarily been distributed among several specialists, among those entrusted with it being Sir John Fowler and Sir Benjamin Baker, as engineers to the railway, Mr. F. Hudleston, as engineer to the Electric Traction Company, Limited, and especially Mr. H. F. Parshall, by whom the plans for the electric construction were made.

The generators, transformers, and rotary converters are furnished by the British Thomson-Houston Company, and the electric locomotives by the General Electric Company of Schenectady, New York, U.S.A.

Gauging Boiler Furnaces.

THE failure of furnaces of internally-fired boilers is generally preceded by a certain degree of deformation, which, if detected in time, may easily be remedied. Even when it is suspected that the furnace is out of truth, it is by no means easy to determine the extent or direction of the deformation, and so the correction of the defect is difficult.

In a paper recently presented before the North-East Coast Institution of Engineers and Shipbuilders, Mr. T. Messenger described a simple and ingenious apparatus for gauging the circularity of boiler furnaces, which not only indicates the irregularity, but also magnifies it.

Briefly, the apparatus consists of three telescopic legs or rods so arranged that they can be placed in the furnace, radiating from a centre pin, and act as a support for a small board to which a sheet of paper can be attached. A telescopic arm, carried on the centre pin, is arranged so that it can be carried around with a roller at the end in contact with the interior surface of the furnace, at the same time yielding to all the irregularities in its shape. A pencil point attached to this arm near the centre traces a closed figure upon the paper, thus furnishing a graphical record of the entire circumference of the furnace, on a reduced scale as regards diameter, but on a full scale as regards the deviation from true circular form.

While this device, as applied to boiler furnaces, appears to be new, a similar apparatus on a much larger scale was applied a number of years ago in the United States for the purpose of investigating the condition of a large circular brick sewer, a radial arm tracing a reduced outline of the periphery of the sewer upon a sheet of paper held at the centre of the sewer. In this instance the influence of earth pressure upon the exterior of the sewer was clearly indicated, as well as the distortion due to settling and erosion.

The advantage of such a method over that of a mere record of diametral measurements is obvious, and the principle is capable of wide application.

Railway Business in Japan.

IN the course of a series of articles in *The Engineer* upon "Modern Japan," some interesting points are made concerning the development of Japanese railways and the furnishing of equipment and supplies to this important market; and the progress of the Japanese in mechanical and business experience is well indicated.

At present there are about 2,800 miles of Japanese railway in operation, and the reasonably probable extensions that should result from present schemes, exclusive of the lines now open, amount to about 6,500 miles. At an estimated cost of £4,000 per mile, the expenditure on railway construction, should amount to at least £26,000,000.

"A few years ago the railways were more or less under the control of the foreign staff, who had already their fixed notions as to where and how things should be purchased. Such is no longer the case, and now the purchasing is in the hands of Japanese, many of whom have experience and others who have not, but all of whom are thoroughly theoretically trained.

"To treat with such men on the subject of railway requirements it is essential that thoroughly technical men should represent British firms. As matters now stand, it often happens that a travelling tout who hardly knows a machine from a bale of cotton lays down the law about locomotives to Japanese officials who have spent the whole of their lives in studying the subject.

"Twenty years ago a man armed with a catalogue and a certain amount of assurance, but with no technical knowledge at the back of it, could make some headway. But now the days have passed when a 'dry-goods man,' whatever that may be, can expect to do much in the way of selling machinery in Japan. The Americans have realised this, and employ the best men they can lay hands on. It will be policy for British makers to look carefully into this matter, and not necessarily to give their representation to the man who will work for the smallest salary or on the lowest commission,—at all events, where railway materials are concerned."

The Bursting of Copper Pipes.

IN the course of a review of the boiler explosions which occurred during 1897, *The Engineer* discusses the question of copper pipes on shipboard,—a matter which comes up periodically, and which on this occasion is revived because of the accident on the steamship *Prodano*, where the bursting of a brazed copper pipe caused the death of four persons.

The investigation showed that the pipe burst at the brazed seam, and that, although it had been tested far above the working pressure when it was first put in in 1889, and at reduced pressure several times thereafter, the explosion was due to original defective brazing of the pipe. According to the court, too long a time had been allowed to elapse without subjecting the pipe to a suitable hydraulic test, as by no other process could its condition have been ascertained.

The Engineer calls attention to the fallacy in assuming a test by hydraulic pressure to be a reliable method of detecting weakness in pipes of this sort, or of measuring their full capacity to stand the stresses which may be thrown upon them. The great objection to the hydraulic test is the fact that it may bring about a false sense of security.

Nearly all instances of steam-pipe failures are due to circumstances which no hydraulic test could have indicated.

In many cases there are sudden shocks caused by racing of the engines, or the impact of water-hammer, or cramping strains due to insufficient provision for flexibility; and these causes are sufficient to induce stresses far beyond those produced by the gradual application of internal hydraulic pressure.

The hydraulic test should, indeed, be applied as thoroughly as the board of trade requirements demand, but other things should also be looked after. Automatic drainage should be provided, so that shocks from entrained water could not occur; and the pipes should be so shaped and erected as to insure plenty of flexibility, since it is from the absence of these precautions that most of the serious accidents have occurred.

THE CONTINENTAL PRESS

The Purification of the Seine.

WE referred several months ago in these columns to the important sewer construction works now under execution in Paris. Now we have, in the *Bulletin de la Société d'Encouragement*, a paper by M. G. Bechmann, the chief engineer of the sanitary department of Paris, giving a very full account of the methods and work which have been employed for the protection of the Seine from sewage contamination, and the measures which have been taken to develop the sewage farm system in the vicinity.

The supply of drinking-water for Paris is brought from a distance, and the discharge of sewage into the Seine had no bearing upon that problem; but the foul condition of the river long ago called attention to the necessity of doing something, and in 1855, when the transformation of Paris under the energetic direction of Haussmann was undertaken, measures were taken to prevent the discharge of sewage into the river within the limits of Paris.

This was accomplished by carrying large collecting sewers along each bank of the river to receive the discharges from the sewers which had formerly emptied directly into the stream, these collectors delivering the entire discharge into the Seine at Asnieres, below Paris, the bend of the river making this connection direct and convenient.

So far as the residents of Paris were concerned, this work, which was completed in 1867, was entirely satisfactory, but the increasing foulness of the river below Paris soon called for relief, and, after the troubles of 1870-71 were over, the sewage farms of Gennevilliers were started, and what was formerly a sandy waste was converted into a thriving market garden, while the river was also much improved.

Since then urgent efforts have been made to extend the system, mainly through the efforts of the engineers of Paris, MM.

Mille and Durand-Claye, but for a long time there was a most unreasoning opposition among the residents and property-holders of the department of Seine-et-Oise, who feared that their property was to be depreciated by the creation of an offensive nuisance. Prohibitory damages were demanded, and even the local authorities united with mobs to interfere with preliminary surveys; hence it took from 1875 to 1889 to secure the passage of the necessary legislation for the construction of the great sewage works and farms at Achères, now completed.

Owing to the several bends in the Seine, the sewage canal by which the discharge is conducted to Achères crosses the river three times. At Clichy pumping is resorted to, four large centrifugal pumps, with vertical axes, each pump directly connecting to its own Corliss engine, lifting the sewage in order to give sufficient head to enable it to pass through a tunnel under the river. The pumping station is arranged to permit the installation of four additional pumps, which will ultimately provide ample capacity for double the existing requirements. The tunnel is itself an interesting piece of work, having been pierced through the bed of the Seine by means of the Greathead shield system, using compressed air and hydraulic pressure, the finished tunnel being lined with bolted cast-iron sections.

The second crossing of the Seine at Argenteuil is by means of a handsome steel arch aqueduct bridge, a second pumping station at Colombes lifting the flow to the required height, from which the principal aqueduct at Achères conducts and distributes the sewage over the farm territory. A portion of the land at Herb-lay lying in another bend of the river required a third crossing, which was accomplished by a submerged siphon composed of two riveted steel pipes. This siphon was prepared upon the surface and then sunk to a foundation of piling at the river-

bed, the pipes being bedded and enclosed in concrete.

The completion of this great work practically takes all Paris sewage-discharge from the river and deposits it in a dilute and inoffensive form upon a sandy, gravelly tract, formerly worthless for agricultural purposes, and now rapidly becoming valuable garden land. The water, after it has filtered through the soil, is practically clean and pure, and there is not the slightest objection to its discharge into the river, where it finds its way only by the slow natural process of percolation through the porous soil.

The engineering details of this great work reflect much credit upon M. Bechmann and his assistant, M. Launay, for, although the general plans were executed practically as they had been conceived and arranged by MM. Mille and Durand Claye, many important constructive features had to be devised as the work progressed. The entire operation of the system is even yet not complete, but it is expected that those who visit the exposition of 1900 will find the Seine as free from contamination as if Paris were not situated upon its banks.

Notes on Testing of Materials.

IT has been known for some time that a distinction must be made between real and apparent resistance to tension, the two being by no means always identical. Pieces from the same bar, in metal testing, turned to the same diameter, will give different results in the testing machine, according to the length of the reduced portion or the character of the reduction, and, unless the entire conditions of the test are reproduced, no one can be sure that the results will be repeated. Under these circumstances it is important to investigate the conditions which will indicate the true strength of a material under test, and this subject is discussed in a paper by Professor C. Bach, read before the *Württembergischen Vereines für Baukunde*, and published in the *Zeitschr. des Vereines deutscher Ingenieure*.

Professor Bach confines himself principally to the testing of cement, and shows how greatly the form of the test specimen

may influence the result, together with the reason for such action. The unequal manner in which various portions of a section act to resist tension is shown by an experiment made by Herr Föppl upon a test-piece made of rubber, in the form usually made for cement test briquettes. By taking such a rubber piece and drawing lines upon it with India ink, and then subjecting it to tension, it will be seen, upon examining the curvature which the lines assume, that certain portions are stretched to a greater extent than other parts. In the case of the cement briquette form, it is found that the outer fibres stretched four times as much as the central portion, or twice as much as the mean elongation; so that it is far from the truth to assume that the entire section is uniformly strained, and we are not always justified in dividing the total stress by the sectional area in order to obtain the stress per unit of section.

Rubber is used to illustrate this action only because of the greater stretch which can be given to it, but Herr Föppl assumes that the distribution of stresses is practically similar in other materials, such as cement, iron, and steel.

It is evident that, if the stress were uniformly distributed over the whole cross-section, the actual resistance would be much greater than when certain portions have to bear an undue proportion, and, according to Föppl, in such cases as the briquette form, a lower strength is indicated by the testing machine than the material really possesses.

It does not follow, however, that this is a general rule, applicable to all kinds of materials. Professor Bach gives examples of a series of tests made upon wrought iron, in which the highest resistance is shown for the shorter specimens, contrary to Föppl's conclusion.

With cast-iron specimens, however, the action is similar to that of the rubber example,—*i. e.*, the test resistance is greater for the long specimen than for the shorter pieces. In both instances also it is necessary to consider the extension, and the reduction of area, which, in the case of wrought iron, is greater for the longer

specimens, while in the case of cast iron there is practically no difference.

Turning now to cement, Professor Bach made comparative tests with specimens of the ordinary briquette form and with the same mixtures in a longer prismatic form, the cross-sections being identical, and the results showed the reverse of what the deduction from the rubber model indicated, the longer specimens having a much lower strength than the short briquettes. This he considers partly due to the fact that it is not practicable to secure as homogeneous a mixture and as thorough hardening with long specimens as with shorter ones,—a view which is borne out by the fact that test specimens of large diameter give lower results per unit of area than smaller diameters. Even with the greatest care in mixing and incorporating the materials, Professor Bach maintains, it is not wise to assume that large masses of cement have as great strength as that shown by smaller test specimens.

For this reason it is never wise to assume that any cement mortar may safely be subjected to a greater tensional stress than that indicated by tests upon standard briquette specimens; on the contrary, it is advisable to assume that in practice a lower strength will exist than that shown by the test.

While it is not safe to draw conclusions as to the magnitude of stresses from the behaviour of rubber specimens, much may be learned from them as to the direction and nature of the deformations caused in other and more rigid materials.

The Measurement of Flowing Water.

FROM the earliest times the measurement of the flow of water has been considered one of the most important of engineering problems, and, in one shape or another, it has occupied the attention of eminent engineers of all countries.

It is only within comparatively recent years, however, that the great influence exerted by the nature and condition of the surface of the channel has been appreciated, and since 1850 the experiments originated by Darcy and continued and

expanded by Bazin have had a profound influence upon the labors of hydraulic engineers who have studied the subject.

The formulas now used owe their form to Darcy, while the experiments of Bazin showed, approximately at least, the allowance to be made for channels of various degrees of roughness.

At the present time, however, the greatly-expanded form of Darcy's formula, due to the industry and ability of Messrs. Ganguillet and Kutter, and known all over the world as "Kutter's formula," is generally considered the most accurate expression from which the mean velocity of a stream of flowing water may be computed, and, notwithstanding its apparent complexity, it is very generally used.

Now, however, we have a new formula, presented by M. Bazin himself, based largely upon the data that were used by Ganguillet and Kutter, with additional experiments included, and from the original memoir contributed by M. Bazin to the *Annales des Ponts et Chaussées* we give an abstract of this important addition to the science of hydraulic engineering.

In reviewing the numerous gaugings upon which the determination of the values for the constants of his formula depended, M. Bazin saw that by no means all were entitled to the same weight. The experiments upon certain classes of small channels were few, but, owing to the care and accuracy with which they were made, were entitled to much greater authority than were the much greater number of observations and gaugings of large streams, in which the same degree of precision could not be expected.

After thus weighing the probable value of each experiment, the result was reduced to the general form adopted, and plotted graphically, so that the whole mass of data was formed into a system of lines, from which the general law could be deduced.

Upon the method adopted in making the gaugings largely depended the importance attached to each series of gaugings used. The uncertainty involved in the use of double floats rendered velocity measurements made in that manner less reli-

able than those made with current meters of the Woltman mill type, since, with the improved instruments of this kind, the various velocities at many points in the same cross-section can readily be determined, and a mean value found.

It was apparent that a coefficient of roughness must still be employed, and, as M. Bazin well remarks, it is in the choice of this coefficient that the judgment and experience of the engineer must appear.

It is impossible here to give the detailed computations by which M. Bazin arrived at the new formula, but we give it as it finally appears, in order that its simplicity, as compared with the preceding formulas, may be seen.

If U be the mean velocity in meters per second, I the slope, and R the hydraulic radius,—i. e., the cross-section divided by the wetted perimeter,—we have:

$$U = \frac{87 \sqrt{RI}}{1 + \frac{\gamma}{\sqrt{R}}}$$

in which γ represents the coefficient of roughness, which may be selected from the following table, according to the nature of the walls of the channel:

For very smooth walls, cement, planed boards, etc.	0.06
For fairly smooth planks, brick, dressed stone.....	0.16
For walls in ashlar masonry.....	0.46
For walls of an intermediate character, such as regular sections in earth, or with stone embankments.....	0.85
For canals in earth, under ordinary conditions.....	1.30
For canals in earth, of unusual resistance, with weeds, etc....	1.75

It is claimed that the new formula is rather more than an empirical rule, and that it contains some features indicating that it may represent some of the characteristics of a truly rational formula.

This will appear from the following considerations. If the cross-section be indefinitely increased, the resistance becomes independent of the nature of the walls—a principle which we might have admitted *a priori*. Moreover, the roughness is no

longer defined by two parameters, as in the previous formula of M. Bazin, but by a single constant, γ , which increases with the specific resistance of the bed, and which may properly be called the coefficient of roughness. It is found that the formula represents with a close degree of accuracy not only the data from which it was deduced, but also those measurements to which it has subsequently been applied.

The high reputation which attaches to all the work in hydraulic engineering thus far accomplished by M. Bazin will undoubtedly cause this new formula to be used with reliance by engineers in many countries, and experience should soon confirm the correctness of the deductions which he has so confidently put forth.

Tests of Railway Ballast.

SINCE 1895 an investigation has been conducted by the royal testing laboratory at Berlin upon the relative value of gravel and broken stone as materials for ballast in railway construction, and the report of Professor Rudeloff, by whom the tests have been conducted, is now made public in the transactions of the laboratory.

Several sorts of gravel were included in the tests, and all the material was sampled by passing given weights through sieves of meshes ranging, in six sizes, from 6 to 50 millimeters mesh, or about $\frac{1}{4}$ inch to 2 inches. The various kinds of gravel varied somewhat in size, but, taking the average,—about 60 per cent.,—ranged between $\frac{1}{2}$ inch and one inch, while fifty per cent. of the broken stone was above the two-inch size.

The materials were subjected to four different kinds of tests: for the resistance to blows of the ramming tool; for the resistance to the wearing and shattering action due to the vibration of the rails under the action of trains; for the resistance to the direct pressure of the loads upon the rails; for the resistance to the disintegrating influences of weather and frost.

In order to be able to measure the effects of these various influences upon the materials, the proportion of the different sizes of stone in each sample was carefully determined in the original state;

and, again sizing the material after testing, the increase in the smaller sizes showed the extent to which the material had suffered by the test.

The tests were made mechanically, so that they could be reproduced exactly for the different materials, thus insuring identical conditions and enabling intelligent comparisons to be made. In the case of the ramming tests, a tool similar to the bar used in actual work, arranged in a machine devised by Professor Martens, acted upon a mass of stone or gravel placed in a box with stout walls, in which the confined material was rammed, tests being made with 100, 300, 600, and 800 blows upon successive boxfuls,—100 blows corresponding to about 1,500 foot-pounds, and the other tests being in proportion.

The action of passing trains over sleepers was reproduced by blows of a drop ram upon a wooden beam resting upon the ballast, three tests being given to each sample, with 500, 1,000, and 1,500 blows; 500 blows equalling about 11,400 foot-pounds.

The tests for resistance to direct pressure were made upon material in the following conditions: entirely dry; soaked with water for two hours; frozen; and wet material which had been frozen and then partially thawed. The ballast for these tests was rammed into a cast-iron pipe, and then subjected to pressures of 20 to 40 tons, in the 100-ton Pohlmeier testing machine.

The results of these tests are very fully tabulated in Professor Rudeloff's paper, and graphical diagrams are also given, which enable the behaviour of the different kinds of ballast to be understood by inspection. To these tables and diagrams the interested reader must be referred for the details, as we can give here only some of the general conclusions.

The various kinds of gravel showed as great differences in resistance as compared with each other as did the broken stone as compared with the gravels; and one of the gravels—that from the river Eder—gave results almost identical with those given by the broken stone, so far as endurance was concerned. This is especially

interesting, since this particular gravel was the one which showed the most general distribution of pebbles of various sizes.

In the matter of resistance to vibration, those gravels which contained the larger pebbles gave the better results, the resistance increasing as the proportion of larger sizes increased; in this respect some of the gravels showed even better results than did the stone ballast.

The general results of all the varied tests, while not altogether harmonious, showed that stone possesses no advantage over well-selected gravel, but that, on the contrary, some gravels show higher resistances under the tests than the rock ballast. In fact, the stone appears to represent very nearly the mean of the results obtained with the six varieties of gravel tested. In the United States stone is sometimes used because of its freedom from dust, and, while this is hardly a mechanical feature, it has much to do with the comfort of passengers, although with it also comes a much greater amount of noise.

While some of the methods of test may not have reproduced the conditions of actual service as faithfully as might be desired, and, while it would have been better to have had as many kinds of stone as gravels, these tests may fairly be considered a valuable contribution to our knowledge of the behaviour of materials of railway construction.

Internal Friction.

AT the international congress of the association for the testing of materials of construction, held in connection with the recent Stockholm exposition, a number of valuable papers were read, some of which have been already reviewed.

An important paper by Professor Rejtö, of Budapest, presented at that time is now reviewed by Professor Kick in the *Zeitschr. des Oesterr. Ingenieur und Architekten Vereines*, and, as the treatment is somewhat novel and interesting, it demands attention.

Professor Rejtö discusses what he terms the internal friction of rigid bodies, par-

ticularly with regard to the action of tools in displacing material, as in the various operations of machining, and considers the manner in which the molecules must act upon each other when cohesion is overcome.

When a specimen of any given material is tested to destruction under compression, the fracture is nearly always of a conical or pyramidal form; or, rather, the mass assumes the shape of two pyramids with their apexes together and their bases at the pressure plates, the material on all sides crushing away under the action of the forces transmitted through the molecules of the body. A similar form of rupture is seen when the chips produced by a planer or shaping machine are examined, these evidently being forced off by what we call the cutting action of the tool. According to Professor Rejtö, the action of the tool is really transmitted to the surface of rupture through the molecules of the material itself, the resistance being opposed by the internal molecular friction; by studying the manner in which pressure is transmitted through a mass composed of spherical particles, he shows how this hypothesis explains the form generally assumed by the ruptured section.

In order to show what he means by the internal friction, and how its value can be determined, Professor Rejtö takes an illustration. If we consider a body subjected to compression between two plates, as the plates approach each other the test specimen becomes shorter, but increases in diameter. Now, the work performed is measured by the product of the internal friction and the increase in diameter, and the force which under tension would produce an extension equal to the increase in diameter gives the value of the internal friction in the case under consideration.

Applying this principle to an analytical and graphical investigation, it is possible to compute coefficients of internal friction, and to classify various materials into groups, according to the constancy of these coefficients. Upon the lines thus marked out, our stock of knowledge concerning the true nature of materials may be decidedly augmented.

Incandescent Lamps.

THE successful introduction of incandescent gas lighting has been followed by a partially successful extension of the method to devices in which the necessary heat is furnished by the combustion of other materials than gas. Some of these lamps use petroleum, sprayed into a vaporizing tube by the action of compressed air, the oil vapor being then burned under a thorium mantle. The blast of heated oil vapor under high pressure produces a most brilliant incandescence. For portable use, however, lamps have been made which require no reservoir of compressed air, and, in a discussion of improvements in illumination by the German Society of Mechanical Engineers, published in *Glaser's Annalen*, some points in regard to the progress of this method of incandescent lighting are brought out.

The lamp most extensively used in Germany is the so-called *spiritus glühlicht*, or spirit incandescent lamp, and, according to Herr Gerdes, the firm of Julius Pintsch has made and put into use about thirty thousand lamps of this character, of various kinds.

The construction of the spirit incandescent lamp has been varied somewhat since its introduction, but the general principle is the same, a wick being used, over which the mantle is placed while the force of the flame is augmented by the blast of vaporized spirit which has passed through a thin tube exposed to the heat of the flame.

In the early forms, these lamps consumed about 150 grammes of spirit per hour, and produced a light of about 50 carcels, corresponding to about 475 c. p. Later improvements, especially with the aim of maintaining a constant level of the spirit and a better construction of burner, have lowered the consumption to 110 grammes per hour, and at the same time increased the illuminating power to 80 carcels, or 760 candles.

The moderate cost in Germany of methylated spirit suitable for use in these lamps makes them more available than in countries where the cost is higher; but

even in Germany the cost of the spirit has led to attempts to make petroleum incandescent lamps. According to Herr Gerdes, however, the firm of Julius Pintsch has not succeeded as yet in making a satisfactory petroleum burner for use with incandescent mantles; in fact, most of the claims made for petroleum incandescent lamps seem to be somewhat tardy of fulfilment, in Germany at least.

This may partially be accounted for by the fact that there is a general desire in Germany to avoid becoming too large a purchaser of petroleum, since this would cause a rise in price which could hardly be resisted, in view of the control of the petroleum market. One of the strongest reasons urged for the development of the spirit incandescent lamps appears to be the desire to become independent of the petroleum monopoly, and in the present temper of Germany against the use of articles controlled in other countries and in favor of advancing home products this factor may become important in the development of the spirit lamp and against the use of petroleum.

A Tunnel Under the Strait of Gibraltar.

A NOTE in a recent issue of *Le Génie Civil* gives an outline of a plan proposed by M. Berlier, (who has already shown his ability in this line by constructing two tunnels under the Seine) for a tunnel under the strait of Gibraltar, connecting Europe with Africa.

A map and a profile show the plans proposed very clearly, and, although the probability that the scheme will ever be executed is very remote, the novelty of the idea renders it worthy of brief notice.

Owing to the depth of water, it is impracticable to consider a tunnel at the narrowest point between the two continents, as the grades of approach would be too great. It is also considered desirable to have the European entrance not too close to the British possessions, as communication might be interrupted between France and Algiers in case of war in which England was involved.

For these reasons the plans show the tunnel as starting at the Baie de Vaqueros,

as an extension of the railway between Cadiz and Malaga, and running in a straight line across to Tangier; and, on emerging on the African side, the road is projected as far as Ceuta, in Morocco.

The total length of tunnel, as indicated on the plans, is 41 kilometers,—about 25½ miles, of which about 20 miles is submarine work.

M. Berlier maintains that the constructive difficulties would be no more difficult to surmount than those encountered in the Mont Cenis, St. Gothard, Arlberg, or Simplon tunnels. The principal difficulty to be anticipated is the infiltration of water, for the form of the tunnel, being that of an inverted siphon, renders the removal of water and the accomplishment of effective ventilation a rather troublesome task.

It seems doubtful whether such a project could be made commercially successful, even if the engineering difficulties could be successfully overcome. By taking into account the cost of great Alpine tunnels, M. Berlier believes the tunnel between the two continents could be made for 123,000,000 francs,—with the cost of the additional railway construction involved, a total expenditure of 225,000,000 francs; while he estimates an annual income of 6,935,000 francs from the system. It is more than probable, however, that the cost of construction would exceed the estimate, and that the receipts would fall short; and it is difficult to believe, in the present state of affairs, that such a work could prove a paying investment.

The Stability of Framework.

THE usual methods of computing the stability of framed structures involve some data which can be determined with a reasonable degree of precision, including, as they do, the weights of the various members and the maximum permissible loads which they are intended to bear. There are, however, other stresses which are not so readily calculated, involving forces which, at the best, can only be assumed, and the action of which is by no means so definitely understood. The most important of these latter stresses are those which act in a lateral direction, including

as the most important the wind pressures upon exposed surfaces.

A valuable paper upon this subject, by Herr L. Geusen, appears in the *Zeitschrift des Vereines deutscher Ingenieure*, and, although, from its mathematical nature, it cannot be fully discussed here, some of the more important conclusions may be noted, and the original commended.

The principal feature of wind stresses is the fact that they are exerted in an entirely different direction from that of the action of gravity; furthermore, they continually shift in direction, and, generally speaking, may occur from any quarter.

In order to provide for any possible contingency, Herr Geusen deduces equations for certain structures assuming the maximum force as coming successively in various directions; and, combining the resultant action upon the members with that due to the vertical forces, he discovers the combination which produces the maximum stresses in the various members of the framework. In these investigations the cases are considered in which, for any reasons of partial sheltering, only certain portions of a building are exposed to the force of the wind, and in which, therefore, very unequal and distorting combinations of strains may occur. Just such cases occur in actual practice, and usually, when a structure has failed to stand against wind pressure, it is because some unforeseen combination of forces has acted in some quite unexpected manner.

Since it is the unexpected which usually happens, it is well to be prepared, and, in order to assist in meeting the conditions which are usually neglected, Herr Geusen has collected a series of skeleton diagrams of the more commonly occurring framed structures, and gives the equations for these when considered as subject to lateral stresses upon such portions as appear to cause the maximum strains. A careful study of these diagrams, together with an examination of the theoretical and practical conditions upon which they are based, will do much to make the method of analysis clear, and the student of applied mathematics will find the paper of practical value.

A Sliding Overhead Trolley.

THE under-running roller trolley is so generally in use for electric tramway service that it is supposed to have demonstrated its superiority over sliding contact, but the use of properly-designed sliding-contact bars shows that the advantage of a roller is more apparent than real.

In the trolley system of Dresden, as described in an article by Inspector von Stobrawa in the *Elektrotechnische Zeitschrift*, the double trolley arm carries a light, slightly-bowed horizontal bar, which is pressed upward against the conducting wire in the way in which a trolley wheel is, the contact being entirely a sliding one.

As might be supposed, the first attempts to employ such a construction, using an iron bar against a copper wire, resulted in a rapid wear. A brass bar covered with white metal was substituted, and, though this much reduced the wear upon the line wire, the bar itself lasted only about two weeks. A further improvement was then made by using an aluminum channel bar with a central bar of white metal, the spaces between being filled with a lubricating grease.

Thus constructed, the bar lasts six to eight weeks, corresponding to about 8,000 car-kilometres, and the general results are satisfactory. Contrary to the first supposition, the wear upon the line wire is less than with the roller trolley, for with the latter the side wear upon the wire is very great, especially upon curves, while with the sliding contact, after a slight flat bearing has been formed upon the conductor, further wear is very slight. These results are obtained from the experience at Dresden, where copper conductors are used. At Basle, where the line conductor is of aluminum, and therefore of greater diameter, the contact area is increased and the wear diminished, so that a trolley bar lasts two or three times as long,—an additional argument in favor of the larger conductor, in this respect at least.

Practical experience with this form of trolley has been had at Berlin, Mulhausen, Hanover, Barmen, and other cities, and for the above reasons it has been found preferable to the roller.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, in the original language, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of \$1.35. In ordering, care should be taken to give the number of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for \$2, forty for \$5, and one hundred for \$12.

This Coupon will be received by us in payment for any 15 cent article catalogued in "The Engineering Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents; thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on. The Engineering Magazine, New York: Please send Article No. _____ to the following address: _____ <i>Facsimile Not Good</i>	With a supply of these coupons on hand, no letter writing is required. Simply fill in the number and your address. A stamped envelope does the rest. This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.
--	--

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
 American Electrician. *m.* New York.
 Am. Engineer and Railroad Journal. *m.* New York.
 American Gas Light Journal. *w.* New York.
 American Geologist. *m.* Minneapolis, Minn.
 American Journal of Science. *m.* New Haven, Conn.
 American Journal of Sociology. *b-m.* Chicago, Ill.
 American Machinist. *w.* New York.
 Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
 American Shipbuilder. *w.* New York.
 Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
 Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
 Annales des Ponts et Chaussées. *m.* Paris.
 Architect. *w.* London.
 Architectural Record. *q.* New York.
 Architectural Review. *s-q.* Boston, Mass.
 Architecture and Building. *w.* New York.
 Architektonische Rundschau. *m.* Stuttgart.
 Atlantic Monthly. *m.* New York.
 Australian Mining Standard. *w.* Sydney.
 Automotor and Horseless Vehicle Journal. *m.* London
 Bankers' Magazine. *m.* New York.
 Bankers' Magazine. *m.* London.
 Bankers' Magazine of Australia. *m.* Melbourne.
 Berg- und Hüttenmännische Zeitung. *w.* Berlin.
 Board of Trade Journal. *m.* London.
 Boston Journal of Commerce. *w.* Boston, Mass.
 Bradstreet's. *w.* New York.
 Brick Builder. *m.* Boston, Mass.
 British Architect. *w.* London.
 Builder. *w.* London.
 Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.

Bulletin de la Société d'Encouragement. *m.* Paris.
 Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
 Bulletin of the Univ. of Wisconsin, Madison, Wis.
 California Architect. *m.* San Francisco, Cal.
 Canadian Architect. *m.* Toronto, Ont.
 Canadian Electrical News. *m.* Toronto, Ont.
 Canadian Engineer. *m.* Montreal, P. Q.
 Canadian Mining Review. *m.* Ottawa, Ont.
 Century Magazine. *m.* New York.
 Chautauquan. *m.* Meadville, Pa.
 Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
 Colliery Guardian. *w.* London.
 Compressed Air. *m.* New York.
 Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
 Consular Reports. *m.* Washington, D. C.
 Contemporary Review. *m.* London.
 Deutsche Bauzeitung. *b-w.* Berlin.
 Dingler's Polytechnisches Journal. *w.* Stuttgart.
 Domestic Engineering. *m.* Chicago, Ill.
 Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Engineer. *w.* New York
 Electrical Engineering. *m.* Chicago, Ill.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrochemische Rundschau. *b-m.* Frankfurt.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnisches Echo. *w.* Magdeburg.
 Elektrotechniker. *b-m.* Vienna.

- Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Engineer. *w.* London.
 Engineer. *s-m.* New York.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, Tenn.
 Engineering and Mining Journal. *w.* New York
 Engineering Journal. *s. an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
 Fire and Water. *w.* New York.
 Forester. *m.* Washington, D. C.
 Foundry. *m.* Detroit, Mich.
 Gas Engineers' Mag. *m.* Birmingham, England.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Gunton's Magazine. *m.* New York.
 Harper's Weekly. *w.* New York.
 Heating and Ventilation. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago, Ill.
 Iron Age. *w.* New York.
 Iron and Coal Trades' Review. *w.* London.
 Iron & Steel Trades' Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco, Cal.
 Journal Franklin Institute. *m.* Phila., Pa.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *q.* New London, Conn.
 Journal Political Economy. *q.* Chicago, Ill.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kan.
 Locomotive. *m.* Hartford, Conn.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore, Md.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Master Steam Fitter. *m.* Chicago, Ill.
 Mechanical World. *w.* London.
 McClure's Magazine. *m.* New York.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, Pa.
 Mining and Sci. Press. *w.* San Francisco, Cal.
 Mining Industry and Review. *w.* Denver, Col.
 Mining Journal. *w.* London.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Monatsschrift des Württ. Vereines für Baukunde.
 10 parts yearly. Stuttgart.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, Ind.
 National Builder. *m.* Chicago, Ill.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Physical Review. *b-m.* New York.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineer's Club. *q.* Phila., Pa.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago, Ill.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago, Ill.
 Railway & Engineering Review. *w.* Chicago, Ill.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revue de Mécanique. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Sanitarian. *m.* Brooklyn, N. Y.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerisches Bauzeitung. *w.* Zurich.
 Science. *w.* Lancaster, Pa.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Scientific Machinist. *s-m.* Cleveland, Ohio.
 Scribner's Magazine. *m.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, N. Y.
 Southern Architect. *m.* Atlanta, Ga.
 Stahl und Eisen. *s-m.* Dusseldorf.
 State's Duty. *m.* St. Louis, Mo.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, N. J.
 Stone. *m.* Chicago, Ill.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston, Mass.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago, Ill.
 Western Railway Club. Pro. Chicago, Ill.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, Conn.
 Zeitschrift für Lokomotivführer. *m.* Hannover.
 Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Alliance Building.

A Proposed Building for the Scientific Alliance of New York. Report of the Building Committee. Gives history of the efforts to obtain a building for use of the Alliance, and the designs submitted for the new building. Ill. 2800 w. Science—March 25, 1898. No. 19119.

Bank.

The Buffalo Bank of Commerce. Illustrates a modern fireproof structure built for a large bank, and gives details of construction. 1500 w. Eng Rec—March 26, 1898. No. 19132.

Brickwork.

Strength of Brick Masonry. Ira O. Baker. Part first discusses the importance of not underestimating the strength and the extravagance of over estimating it, giving some results of experiments. 1800 w. Br Builder—March, 1898. Serial. 1st part. No. 19147 c.

The Economy of Brick Structures as Compared with Those of Wood. R. N. Buell. Read at the Pittsburg meeting of N. B. M. Assn. Considers the comparative cost of wood and brick structures, and other advantages, and how to demonstrate the superiority of brick to the builders of American homes. 3000 w. Brick—March, 1898. No. 18787.

Chimney.

The Stability of a Chimney. (Standfestigkeit eines Schornsteines.) J. Goebel. An analytical investigation of the resistance of chimneys of various sections and dimensions against wind stresses. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1898. No. 19244 d.

Church.

The Church of St. Martin, Wareham, Dorset. Charles Lynam. A study of the details of this church, with illustrations. 2500 w. Builder—March 12, 1898. No. 19071 A.

Concrete Construction.

Cement and Steel Buildings. Illustrates the construction of small shops and schools having concrete and expanded metal walls and partitions. 700 w. Eng Rec—March 26, 1898. No. 19133.

Steel Concrete Construction. George Hill. Deals with that combination of concrete and steel in which the steel acts entirely in tension, and in which it is distributed through the bottom section of the slab. An account of tests and results. Ill. 5500 w. Pro of Am Soc of Civ Eng—March, 1898. No. 19107 f.

Court Building.

The Appellate Court Building. Charles H. Coffin. Illustration with brief description of a beautiful building in process of construction at the corner of Madison Ave. and 25th Street, New York City. 600 w. Harper's Wk—April 2, 1898. No. 19188.

Exposition.

Exposition of 1900, Paris. (Exposition de

1900.) Giving the final plans and arrangement of buildings adopted for the Esplanade des Invalides and the Champ de Mars. 800 w. 1 plate. Le Génie Civil—March 5, 1898. No. 19217 D.

Fireproofing.

Burned Clay as a Fire-Proofing Material. W. D. Henry. Read at the Pittsburg meeting of the N. B. M. Assn. Considers the adaptability of burned clay to fire-proofing, the proper way to make it, the results, &c. 3500 w. Brick—March, 1898. No. 18786.

Expanded Metal in Its Relation to Fireproof Construction. J. F. Golding. Paper read at a meeting of the Civil and Mech. Eng's. Society, England. Some information of the manufacture of this material and the uses to which it can be applied. 1400 w. Arch, Lond—Feb. 25, 1898. Serial. 1st part. No. 18842 A.

How to Build Fire-Proof. Francis C. Moore. Considers twelve important propositions bearing on this subject, or rather on slow-burning buildings and their care. 3800 w. Br Build—March, 1898. No. 19149 c.

The Hamburg Experiments on the Fireproofing of Cast Iron, Wrought Iron, and Wooden Columns. (Die Hamburger Versuche über die Feuersicherheit Gusseisener, Schmiedeisener, und Hölzener Säulen.) Tests were made of bare columns, also with sheathings of concrete, asbestos cement and similar materials; discussion is appended. 1800 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1898. No. 19245 D.

Grain Elevators.

Steel Tank Grain Elevators "Electric" and "Fort William." Illustrates and describes the two most recent structures of this class, one at Buffalo, N. Y., the other at Fort William, Ont. 1200 w. Eng News—March 17, 1898. No. 19023.

Theatre.

Revolving Stage of the Paris Variety Theatre. (Scène Tournante du Théâtre des Variétés à Paris.) The inclined floor of the stage revolves like a turn-table, thus enabling one setting to be prepared while the other is being used, and making very prompt changes of scene possible. 1000 w. Le Génie Civil—March 12, 1898. No. 19221 D.

The Housing of the Drama. Edwin O. Sachs. Treats of the aspects under which a playhouse devoted to the drama can be constructed, with special reference to subscription and endowed theatres. Also discussion. Ill. 10000 w. Jour Roy Inst of Brit Archs—Feb. 12, 1898. No. 18834 B.

HEATING AND VENTILATION.

Astoria Hotel, N. Y.

Ventilation of the Astoria Hotel, New York City. A general description of the hotel and the ventilating plant, which has a capacity of 15,000,000 cu. ft. of air per hour. The air is moderately warmed and the heating of the rooms is by direct radiation. Ill. 2200 w. Eng Rec—March 19, 1898. Serial. 1st part. No. 19039.

Blower System.

Some Facts in the History of the Blower System. Walter B. Snow. Traces the progress of this system from its earliest history. Ill. 1500 w. *Met Work*—March 19, 1898. Serial. 1st part. No. 19027.

Church Heating.

The Heating and Ventilation of Central Presbyterian Church and Sunday School, Erie, Pa. Illustrates and describes the installation of a fan system in a building provided only for a system of direct heating. 1200 w. *Heat & Ven*—Feb. 15, 1898. No. 18718.

English Criticism.

An English Criticism on American Practices in Erecting Domestic Hot-Water supply Apparatus. Frederick Dye. The object of the article is to point out faults with the view of showing how the work may be improved. Ill. 1800 w. *Heat & Ven*—Feb. 15, 1898. No. 18719.

French Practice.

Steam Distribution in France Without Pressure in Radiators. Other French Practice. G. Debesson. Brief description of systems of steam distribution through piping into the radiators, also a combination system using both steam and hot water, and other work. Ill. 1100 w. *Heat & Ven*—March 15, 1898. No. 19110.

Gas-Heating Appliances.

The Efficiency and the Waste of Heat in Gas-Heating Appliances. Dr. Haber. Abstract. Gives a mode of calculation where there is no need for an analysis of the gas or for a determination of its specific gravity. 1200 w. *Gas Wld*—Feb. 19, 1898. No. 18734 A.

Heat Transmission.

Transmission of Heat Through Copper Coils. Discusses many experimental results and shows the need of more data. 1000 w. *Eng Rec*—March 5, 1898. No. 18888.

Hot-Water Heating.

English Views on Hot-Water Heating. W. J. Maguire. Brief explanation of the writer's methods and the reasons. 1600 w. *San Plumb*—March 1, 1898. No. 18932.

Pipe Coverings.

See Mechanical Engineering, Miscellany.

Radiating Surface.

A Chart for Determining Radiating Surface. Gives a diagram for reading off readily the radiating surface of any room with either steam or hot-water heating. 700 w. *Eng Rec*—March 5, 1898. No. 18896.

School.

Heating and Ventilating a Bayonne (N. J.) School. Illustrated description of a low-pressure steam heating and ventilating system. 1200 w. *Met Work*—March 12, 1898. No. 18918.

Steam Heating.

Systems and Apparatus for Heating Buildings by Steam. J. J. Blackmore. An exposition of the principles governing the design of an eco-

nomical plant, reviewing the three distinct systems and the conditions under which they are applicable. 3500 w. *Engineering Magazine*—April, 1898. No. 19291 B.

PLUMBING AND GASFITTING.**Astoria Hotel.**

The Astoria Hotel, New York City. Gives some features of the plumbing, drainage, and water supply, describing the Continental system of filtration. Ill. 2800 w. *San Plumb*—March 1, 1898. No. 18931.

Electrical Work.

Plumbing and Electrical Work. James F. Hobart. The first of a series of articles whose aim is to present the matter of simple electrical working in such a plain manner that the principles may be understood and the work executed. 2700 w. *Dom Engng*—March, 1898. Serial. 1st part. No. 19055 C.

House Drainage.

House Drainage from an English Standpoint. James I. Little. Describes the underground drainage, how drains should be laid, &c, in accordance with English practice. 1400 w. *San Plumb*—March 15, 1898. No. 19104.

Lead Pipe.

How Lead Pipe Is Made. Account of the manufacture. 1700 w. *San Plumb*—March 15, 1898. No. 19103.

Lead Work.

Lead Work, Plain and Decorative. F. W. Troup. Describes the uses made of lead by early architects, as roofs, crockets, figures, &c. Discussion. 8500 w. *Builder*—March 5, 1898. No. 18960 A.

Water Pipes.

Computation of Water-Heating and Water-Conducting Systems in an Elementary Manner. (Berechnung von Wasserheizungs- und Wasserleitungs-Anlagen auf Elementarem Wege.) Rudolf Mewes. A very full and elaborate discussion of the practical computation of the dimensions of water pipe systems to obtain a desired capacity of flow. Two articles. 10000 w. *Gesundheits-Ingenieur*—Jan. 31, Feb. 15, 1898. No. 19284 each B.

MISCELLANY.**Architectural Study.**

On the Study of Architecture. George Aitchison. An address delivered before the Birmingham Arch. Assn. Some suggestions as to the proper course to be pursued by students, and the aims of true architects. 2300 w. *Brit Arch*—March 11, 1898. No. 19069 A.

Artificial Marble.

Artificial Marble in Sicily. Information concerning the manufacture of artificial black marble. 800 w. *Cons Repts*—March 26, 1898. No. 19144 D.

Bradford, Eng.

The Architecture of our Large Provincial Towns. Illustrated description of the architecture of Bradford, England. 5800 w. *Builder*—Feb. 19, 1898. No. 18732 A.

Campanili.

The Mediæval Campanili of Rome. J. Tavenor Perry. Illustrated description and historical account of these bell-towers. Also discussion. Ill. 8000 w. Jour Roy Inst of Brit Archs—Feb. 26, 1898. No. 19150 B.

Columbia University.

Columbia University, N. Y. Illustrated description of the new buildings, especially the library, with brief history of the college. 3000 w. Sci Am—March 26, 1898. No. 19090.

Efflorescence.

On the Saline Efflorescence of Bricks. Oscar Gerlach. Considers the causes leading to it, and the practical means of avoiding the same. 2300 w. Br Build—March, 1898. Serial. 1st part. No. 19148 c.

Egypt.

Egypt, the Birthplace of Architecture. G. A. T. Middleton. Read before the Society of Architects, England. Historical description of the architecture of this country. 3500 w. Arch, Lond—March 4, 1898. No. 18957 A.

Expositions.

The Tennessee Centennial Exposition. Brief discussion of the plan with criticisms. 2400 w. Arch Rev—Vol. V. No. II., 1898. No. 19112 F.

The Trans-Mississippi Exposition. C. Howard Walker. Illustrated description of the architecture, with general discussion of the requirements of buildings for expositions. 4000 w. Arch Rev—Vol. V. No. II. 1898. No. 19111 F.

Fees.

The Law of Architects' Fees in Scotland. Gives the decision of a case in Edinburgh, by Lord Kincairney. 1200 w. Arch, Lond—March 18, 1898. No. 19155 A.

Kensington.

Kensington Palace. From the London Times. An account of this noted palace, the birthplace of Queen Victoria, and description of some parts of it. It is to be put in order and opened to the public. 2000 w. Arch, Lond—Feb. 18, 1898. No. 18736 A.

Monuments.

The Conservation of Historical Monuments in Italy. Alfredo Melani. Reviews the provisions made for this purpose, and the mistakes which resulted in the loss of many monuments. 2700 w. Am Arch—Feb. 26, 1898. No. 18753.

Mosaics.

An Improved Process and Apparatus for Manufacturing Mosaics. Report of the Institute, through its Committee on Science and the Arts, on the invention of Herman C. Mueller, of Zanesville, Ohio. Description of the invention, with commendation. 2700 w. Jour Fr Inst—March, 1898. No. 18810 D.

Pompeii.

Pompeii—A City of the First Century. Prof. Adams. Abstract of a lecture delivered before the resident members of the Province of Quebec Assn. of Architects at Montreal. An interest-

ing historical and descriptive account of this ancient city. 6200 w. Can Arch—March, 1898. Serial. 1st part. No. 19058 c.

Pyramids.

Scientist Explodes the Mystery of the Pyramids. J. D. McGuire in the *Indianapolis News*. Abstract. The story of their erection, processes of construction, &c. 2000 w. Stone—March, 1898. No. 19106 c.

Renaissance.

The Florentine Renaissance. George Aitchison. The fourth Royal Acad. lecture on architecture this session. Considers the works and influence of the celebrated architects of this period. 2500 w. Builder—Feb. 26, 1898. No. 18866 A.

The Florentine Renaissance. George Aitchison. The fifth Royal Academy lecture on architecture this session. Describes some of the most remarkable buildings of the architects of this period. 3500 w. Builder—March 5, 1898. No. 18959 A.

The Middle and Later Renaissance. George Aitchison. The sixth and last Royal Academy lecture on architecture this session. The influence of Vitruvius' work, and a review of the fine buildings of this period. 3800 w. Builder—March 12, 1898. No. 19072 A.

Scottish Churches.

Scottish Church Architecture of the Fourteenth and Fifteenth Centuries. Hippolyte J. Blanc. Read at meeting of the Architectural Assn., London. Sketches some of the most prominent examples and makes comparison with contemporaneous work in England. 4500 w. Arch, Lond—March 18, 1898. No. 19154 A.

Store Fronts.

The Painting and Decorating of Store Fronts. Walter J. Pearce. Suggestions for the use of characteristic details in the ornament of shops. The illustrations given are such as could be used on pilasters. 2400 w. Plumb & Dec—March 1, 1898. No. 18962 A.

Terra-Cotta.

Architectural Terra-Cotta. Thomas Cusack. Considers the importance of coöperation between architect, engineer and clay worker, illustrating by example the defective work resulting from the lack of coöperation. Ill. 2000 w. Br Build—March, 1898. No. 19146 c.

Unfinished Work.

Thoughts Suggested by the New Porches of Trinity Church, Boston. H. R. M. Questioning the wisdom of attempting to complete this unfinished work of Richardson. Ill. 2200 w. Scribner's Mag—April, 1898. No. 19117 c.

University.

The Surroundings and New Buildings of the University of Leipzig. (Die Um- und Neubauten der Universität Leipzig.) With plans of the old arrangement when the cloister was standing, also the condition before the new work, as well as the present improved arrangement. 1800 w. Deutsche Bauzeitung—Jan. 22, 1898. No. 19287 B.

CIVIL ENGINEERING.

BRIDGES.

Arch.

Beton Bridge with Imbedded Iron Ribs. (Betonbrücke mit Eisenrippen-Einlagen.) A very light and effective Melan Arch of 72 feet span forming a roadway over the Klampenborg-Helsingør railway near Skodsborg, Denmark. 800 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 25, 1898. No. 19259 B.

Boat Bridge.

Boat Bridge Over the Indus at Khushalgarh. Brief account with illustration. 400 w. Ind Engng—Feb. 19, 1898. No. 19151 D.

Bridge Removal.

Renewing a Bridge. Describes an interesting engineering feat performed by the Chicago & Northwestern Railway, in the removal of the old drawbridge near Kinzie street, Chicago, and the substitution of a new span. Ill. 700 w. Ry Age—March 18, 1898. No. 19054.

Bridge Shops.

Notes from American Bridge Shops. Part first presents information of the Elmira Bridge Co., of Elmira, N. Y., and the Union Bridge Co., of Athens, Pa. Ill. 2200 w. Eng News—March 3, 1898. No. 18774.

Cantilever.

Partially Connected Cantilever Bridge over the Chélif. (Pont à Jonction Centrale Partielle sur le Chélif, Algérie.) Describing a peculiar form of cantilever in which a partially rigid connection is made in the middle of the central span. 2000 w. Le Génie Civil—Feb. 26, 1898. No. 19215 D.

Foundations.

Submerged Concrete Laying. Slightly condensed from the report of William Jackson. Describes methods used on a bridge at Boston, Mass. 1500 w. Eng Rec—March 5, 1898. No. 18890.

Depositing Concrete under Water at Charlestown Bridge, Boston, Mass. Describes some difficult work in making the foundations for two of the piers of this bridge. Ill. 1400 w. Eng News—March 17, 1898. No. 19026.

Highway Bridge.

A Highway Bridge with Concrete and Brick Floor. L. B. Merriam. A bridge lately erected in DeKalb, Ill., of interest because of the unusually heavy dead load caused by the use of concrete and brick for driveway floor, and concrete sidewalks. 1200 w. Eng News—March 10, 1898. No. 18912.

The Construction of a Road Bridge over the Doubs at Verdun. (La Construction d'un Pont Route sur le Doubs à Verdun.) Detailed description of this handsome stone arch bridge, of three spans, 135 feet each. Diagrams of the masonry and the centerings are given, and photographs of the completed structure. 3000 w. 2 plates. Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19236 F+G.

Queensland.

Burdekin River Bridge—Queensland Government Railways. H. C. Stanley. Illustrates and describes a high-level bridge in Australia. 900 w. Ry & Engng Rev—March 19, 1898. No. 19078.

Replacement.

Replacement of the Old Metal-Span of the Pennsylvania Railroad Bridge Over the Schuylkill River at Philadelphia, October 17, 1897. Joseph T. Richards. Description showing the preparations and conditions under which a transfer was made in 2 minutes and 28 seconds. Ill. 3000 w. Pro Engs' Club of Phila—Jan., 1898. No. 18767 D.

Steel Bridge.

Mill Street Bridge, Watertown, N. Y. Illustrates and describes a short-arch bridge of unique design erected by an unusual form of false work. 1300 w. Eng Rec—March 5, 1898. No. 18889.

Swing-Bridge.

Chicago, Madison, and Northern Railroad Company's Bridge. Details of superstructure of a double-track 474-ft. swing-bridge, with illustrations. 1000 w. Eng Rec—March 19, 1898. No. 19035.

Viaduct.

Designs for the Massachusetts Avenue Viaduct at Washington, D. C. Two designs for crossing Rock Creek, one a stone arch, and the other a steel arch. Ill. 600 w. Eng News—March 10, 1898. No. 18908.

Wooden Bridges.

The Life of Wooden Piles and Bridges. William Gammons. Abstract of an address before the bridge and building department of the C. M. & St. P. Ry. 1000 w. Eng Rec—March 12, 1898. No. 18926.

CANALS, RIVERS AND HARBORS.

American Harbors.

Great Harbors on Our Seaboard. Cyrus C. Adams. Describes some of the harbors of the United States, and their commercial importance. 2500 w. Chau—April, 1898. No. 19186 c.

Antwerp Port.

The Extension of the Port of Antwerp. Part first gives a statement of the conditions and discusses some of the plans submitted for the extension of the port. 2200 w. Engr, Lond—March 11, 1898. Serial. 1st part. No. 19062 A.

Bear Trap Dam.

Bear Trap Dam for Regulating Works, Chicago Drainage Canal. Detailed illustrations and full description of this dam, the largest structure of its type in the world. 5500 w. Eng News—March 24, 1898. Serial. 1st part. No. 19084.

Breslau.

The Opening of the New Ship Channel at

Breslau. (Zu der Eröffnung des Grossschiffahrts-
weges in Breslau.) Brief description with
photographs of the docks, bridges and locks.
800 w. Zeitschr d Oesterr Ing u Arch Ver—
Feb. 18, 1898. No. 19255 B.

Dismal Swamp.

Reconstruction of the Dismal Swamp Canal.
Description and profile showing the condition of
the canal when the improvements were started,
with account of the work now in progress. Ill.
2300 w. Sci Am—March 5, 1897. No. 18764.

Docks.

A Modern Coal Dock. Edward N. Saunders,
Jr. Describes the dock of the Northwestern
Coal Railway Co., at Superior, Wis. Ill. 1800
w. Yale Sci M—March, 1898. No. 19016 C.

Drainage Canal.

Drainage Canal. Isham Randolph. Statis-
tics relating to the growth of Chicago are given,
with illustrated account of work on the sanitary
canal. 8000 w. Jour of W Soc of Eng—Dec.,
1897. No. 18804 D.

Dredges.

See Electrical Engineering, Power.

Dredging.

European Sea-Going Dredges and Deep-
Water Dredging. E. L. Corthell. Reviewing
the importance of harbor and channel improve-
ment and the increasing use of powerful dredges
for this service, with many illustrations of typi-
cal sea-going dredges of European construction,
and data of capacity and cost of operation. 4500
w. Engineering Magazine—April, 1898. No.
19290 B.

Dry Docks.

Our Naval Dry Docks. An editorial state-
ment placing the blame of naval dry-dock
failures on line officers' interference with civil
engineers. 1200 w. Eng Rec—March 5, 1898.
No. 18886.

The Construction of the Lorain Dry Dock and
Shipyard of the Cleveland Ship-Building Com-
pany. James Ritchie. Illustrated detailed
description of this work. 5000 w. Pro of Am
Soc of Civ Eng—March, 1898. No. 19108 F.

Erie Canal.

The Future of the Erie Canal. Thomas W.
Symons. Advocates federal control. 3000 w.
Eng Rec—March 19, 1898. No. 19036.

Flow.

A Study of a New Formula for calculating the
Discharge of Open Channels. (Etude d'une
Nouvelle Formule pour Calculer le Débit des
Canaux Découverts.) H. Bazin. A most im-
portant contribution to hydraulic engineering by
high authority; developing a much simpler for-
mula than has hitherto been used. The formula
is intended to replace the more complicated one
of Ganguillet and Kutter. 12000 w. 1 plate.
Ann des Ponts et Chaussées—4 Trimestre, 1897.
No. 19232 F+G.

The New Formula of Bazin. (La Nouvelle
Formule de M. Bazin.) An abstract of the ex-
periments of Bazin and his derivation of a new
formula for determining the flow of water in

open channels. 1200 w. Le Génie Civil—
March 5, 1898. No. 19219 D.

Fulda.

The Canal Works on the Fulda Between
Cassel and Münden. (Die Canalisierung der
Fulda zwischen Cassel und Münden.) A.
Herbst. With profile, and plans and sections of
canal locks. 3500 w. 2 plates. Oesterr Mon-
atschr f d Oeffent Baudienst—March, 1898. No.
19282 D.

Harbor Improvement.

Development of the Port of Plymouth, Eng.
An explanation of the two projects before the
local authorities for the improvement and exten-
sion of the port and harbor. 1600 w. Engr,
Lond—Feb. 18, 1898. No. 18724 A.

Improve New York Harbor. Suggestions for
needed improvements from a pamphlet pub-
lished by John W. Ambrose. 1000 w. Fire &
Water—March 5, 1898. No. 18821.

The Improvement of Plymouth Harbor. Plan
showing the position of the proposed works and
describing the arrangements. 1300 w. Engr,
Lond—Feb. 25, 1898. No. 18858 A.

Lighthouses.

The Optical Apparatus of Lighthouses. (Ap-
pareils Optiques des Phares.) M. Ribiére. A
graphical and mathematical treatment of the
figures for the lenses of lighthouse apparatus,
with experimental verification of the theoretical
deductions. 10000 w. 3 plates. Ann des
Ponts et Chaussées—4 Trimestre, 1897. No.
19234 F+G.

Electric Lighting and the Eckmuhl Light-
house. (L'Eclairage Electrique et le Phare
d'Eckmuhl.) M. de Joly. A general description
of the extensive introduction of electric lighting
in the lighthouses on the coast of France, to-
gether with an account of the inauguration of
the new Eckmuhl lighthouse. 12000 w. 2 plates.
—Ann des Ponts et Chaussées—4 Trimestre,
1897. No. 19233 F+G.

New York's Canals.

Federal Ownership of New York's Canals.
Hearing before the Senate judiciary committee
on Wednesday, March 9, on the Pavey resolution
providing for the amendment of the constitution
so as to make possible the transfer of New
York's canals to the Federal Government. 2800
w. Sea—March 17, 1898. No. 18995.

Sea Walls.

Sea Walls on the North Sea Coast. (Strand-
mauern an der Nordseeküste.) With illustrations
showing the different kinds of sea walls and
methods of construction on the coasts of Den-
mark, Holland, Belgium, and Germany. 1800
w. Zeitschr d Oesterr Ing u Arch Ver—Feb.
25, 1898. No. 19257 B.

Sfax.

The Port of Sfax, Tunis. (Port de Sfax.)
M. Bezault. Describing the dredging of the
channel and the construction of the docks and
quays of this port of Tunis, under the direction
of the French protectorate. 4500 w. 1 plate.
Ann des Ponts et Chaussées—4 Trimestre, 1897.
No. 19235 F+G.

Ship Canal.

Proposed Canal from American Lakes to Atlantic. Discusses the project and Major Symons' report. 1100 w. Engng—March 11, 1898. No. 19061 A.

Towing.

See Electrical Engineering, Power.

IRRIGATION.**Central India.**

Tank Irrigation in Central India. George Palmer. Describing the reservoir system of irrigation used in the State of Hyderabad, with an account of the topographic, climatic, and administrative influences affecting the system; with maps and tables. 3000 w. Engineering Magazine—April, 1898. No. 19293 B.

Dam.

The Hemet Dam, California. A plan profile and cross section of this arched-masonry dam, with a few facts regarding it. 800 w. Eng News—March 24, 1898. No. 19087.

The Repair and Extension of the Sweetwater Dam. H. N. Savage. An illustrated description of the construction of this curved masonry dam, and its repair and raising after being overtopped by a heavy flood. 3000 w. Eng Rec—March 12, 1898. No. 18927.

See also Municipal Engineering, Water Supply.

Pump Irrigation.

Pump Irrigation in the West. Hunter Morrison. Describes method of irrigating the Great Plains of Kansas, Nebraska, &c., and the benefit derived. Ill. 1500 w. Yale Sci M—Feb., 1898. No. 18691 C.

MISCELLANY.**Brickwork.**

See Architecture and Building, Construction.

Cableways.

Cableway Transportation and its Applications to Agriculture, Industry and Construction. (Transports par Cables Aériens et leurs Applications à l'Agriculture, à l'Industrie, et aux Constructions.) A paper before the society of civil engineers of France by M. Thiéry showing the economical advantages of cableways, with reference to successful installations in France and in the United States. 2000 w. Moniteur Industriel—March 12, 1898. No. 19242 G.

Cement.

Progress in the Manufacture of American Portland Cement. John W. Dickinson. Brief history of this industry in the United States, with remarks on quality and cost. 1700 w. Munic Engng—March, 1898. No. 18745 C.

Testing Cement. A discussion introduced by Thomas T. Johnston. 2500 w. Jour of W Soc of Eng—Dec., 1897. No. 18806 D.

Concrete Construction.

See Architecture and Building, Construction.

Decimal System.

The Extension of the Decimal System to the

Day and to the Circle. (Sur l'Extension du Système Décimal au Jour et au Cercle.) M. Rey-Pailhade. Presenting the arguments in favor of the practical advantages of the change from the sexagesimal to the decimal division of the circle and the day. 1200 w. Comptes Rendus—Feb. 14, 1898. No. 19224 D.

Explosives.

The High Explosives Used in Naval Warfare. Remarks on the different forms of these explosives and their power and safety. 1300 w. Eng News—March 24, 1898. No. 19088.

Highways.

State Highways in Massachusetts. Editorial giving a statement of methods of selecting state roads and pointing out defects in present laws. 1500 w. Eng Rec—March 26, 1898. No. 19130.

The Influence of Tire Width on Draft of Wagons. Describes experiments at the Missouri Agricultural College showing wide tires to draw easier on all roads, except under conditions arising but rarely. 1800 w. Eng Rec—March 12, 1898. No. 18928.

Malay States.

Engineering in the Malay States. Information regarding the present conditions and future prospects of engineering in this new field. 1800 w. Engng—March 4, 1898. No. 18951 A.

Stability.

Methods of Applying the Trapezoidal Formula to Computations of Stability. (Diverses Manières d'Appliquer la Règle du Trapèze au Calcul de la Stabilité.) Maurice Lévy. Particularly devoted to the application of the method to the determination of the stability of masonry dams, especially against sliding. 2500 w. Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19231 F+G.

Stadia-Rods.

The Conditions of Accuracy of Stadia Rods. (Die Bedingungen der Schätzungsgenauigkeit an Massstäben.) Anton Tichy. A very full investigation of the methods of calibrating graduated rods for use in stadia surveying and the computation of the probable error. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—March 4, 11, 1898. No. 19260, each B.

Surveyors.

County Surveyors and Surveyors-General. J. L. Van Ornum. Reviews the laws of the differing states governing the election of these officers, and shows that changed conditions have made necessary a revision of past practice. Points out the duties required and qualifications needed. 3000 w. Eng News—March 3, 1898. No. 18769.

Tunnel.

Proposed Tunnel under the Strait of Gibraltar. (Projet de Tunnel sous le Détroit de Gibraltar.) With maps, and general outline of the scheme of M. Berlier for the construction of a tunnel under the strait of Gibraltar, between Tarifa in Spain, and Tangier, Morocco. 1200 w. Le Génie Civil—Feb. 19, 1898. No. 19214 D.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Exports.

American Clover Seed in Austria-Hungary. Reports an attempt to exclude this product, claiming that it is infected with klesseide (commonly known as dodder), but the real reason is that competition is having a demoralizing effect on the market. 800 w. Cons Repts—March 28, 1898. No. 19159 D.

Foreign Trade. John A. Johnson. Discussing the possibilities for the manufactured products of the United States. 1600 w. Mach, N. Y. —March, 1898. No. 18874.

Brazil.

New Brazilian Customs Tariff. Statement giving a translation of the section dealing with cotton yarns and manufactures. 2000 w. Bd of Trd Jour—Feb., 1898. Serial. 1st part. No. 18704 A.

Brazil Exports.

Warning to Exporters of British Goods to Brazil. Calling attention to the injury to trade due to piracy of trade marks, owing to the inferiority of the products passed under name of good manufacturers, and the steps taken by the government to control and regulate this kind of trade. 1200 w. Bd of Trd Jour—March, 1898. No. 19301 A.

British East Africa.

Trade and Shipping of the British East Africa Protectorate. Report on the condition and progress since its establishment to the 20th of July, 1897. 1000 w. Bd of Trd Jour—Feb., 1898. No. 18703 A.

British India.

Openings for Capital in British India. Abstract of an article published in a Calcutta weekly on the concentration of industries in British India and the openings for capital which present themselves in that country. 1300 w. Bd of Trd Jour—March, 1898. No. 19303 A.

British Trade.

Foreign Trade of the United Kingdom. Report of the imports and exports for the month, and two months, ending Feb. 28, 1898, with comparison of the previous year. 900 w. Bd of Trd Jour—March, 1898. No. 19300 A.

Canal Traffic.

The Traffic on the "Kaiser Wilhelm" Canal. Report of the British Consul-general at Hamburg on the traffic of this canal during the year 1896-1897. Shows an increase of traffic; also gives other particulars of interest. 1000 w. Bd of Trd Jour—Feb., 1898. No. 18700 A.

China.

British Commercial Relations with China and the Establishment of the Inspectorate General of Chinese Imperial Maritime Customs. A summary of the leading changes in the international commercial relations between Great Britain and China during the present century. 3000 w. Bd of Trd Jour—Feb., 1898. No. 18699 A.

Exports.

French and German Commerce. From the *Leipziger Tageblatt*. Considers the decline of the French export trade, and how it may be arrested. 500 w. Cons Repts—March 26, 1898. No. 19143 D.

Free Trade.

Mr. Gladstone on Free Trade. Gives a statement from an address before the Hawarden Horticultural Society, and discusses the situation at present in England and other countries. 2500 w. Gunton's Mag—March, 1898. No. 18882 C.

French Soudan.

The Trade and Industry of the French Soudan. Information regarding the articles of import, price, etc.; also brief notice of the resources of the country. 1500 w. Bd of Trd Jour—Feb., 1898. No. 18701 A.

Hongkong.

Economic Conditions in Hongkong. A brief review of the industrial and commercial situation of the colony during the past year. 1500 w. Cons Repts—March 12, 1898. No. 18923 D.

Italy.

Imports into Italy. A statement concerning the articles which might be exported from the United States to Italy in competition with other countries. 500 w. Cons Repts—March 7, 1898. No. 18833 D.

National Supremacy.

The Shifting Site of National Industrial Supremacy. J. Stephen Jeans. A review of the causes which have led to the transfer of international contests for supremacy from the military to the industrial field, analysing the conditions which determine supremacy in the struggle. 3500 w. Engineering Magazine—April, 1898. No. 19289 B.

Persian Trade.

The Development of Persian Trade. Considers the trade routes connecting Persia with the outer world, and the division of trade between Russia and Great Britain. Map. 2000 w. Bd of Trd Jour—March, 1898. No. 19302 A.

Prices.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Showing fluctuations in quotations from April 1, 1895, to March 1, 1898. 2800 w. Bradstreet's—March 12, 1898. No. 18944.

Resources and Trade.

South and Central American Republics—Their Resources and Trade. Part first reports the conditions found in Mexico by the commission appointed by the British Government to ascertain the prospects of British trade. Map. 9000 w. Ir & Coal Trds Rev—Feb. 18, 1898. Serial. 1st part. No. 18727 A.

Rubber Prices.

The Higher Prices for Rubber Goods Ex-

plained. Circular prepared by order of the Mechanical Rubber Mfrs. Assn., giving in detail the prices of rubber and showing the advance since 1896. 2700 w. Ind Rub Wld—March 10, 1898. No. 19050 D.

Shipment.

The Shipping and Transportation of Goods. George Eastlake. The proper method of billing goods for shipment; the classification so as to take advantage of the most favorable tariffs; and the routing of shipments to distant points. 1800 w. Ry Mag—Jan., 1898. No. 18760.

Siam.

Trade Opportunities in Siam. Information concerning this country of southeastern Asia, and the opportunities for American exporters and manufacturers. 2000 w. Cons Repts—March 15, 1898. No. 18978 D.

Tariff.

New Brazilian Tariff. A portion of the new tariff, showing the changes made from the tariff of 1896 in the principal products exported from the United States to Brazil. 3400 w. Cons Repts—March 18, 1898. No. 19017 D.

Tariff Changes and Customs Regulations. France, Spain, Italy, United States, Salvador, Venezuela, Brazil, Chile, Peru, British India, Canada, British East Africa Protectorate, Cape Colony, and Queensland. 3000 w. Bd of Trd Jour—Feb., 1898. No. 18705 A.

Tariff Changes and Customs Regulations. Russia, Belgium, Germany, France, Spain, Italy, Switzerland, Roumania, Servia, Bulgaria, United States, Brazil, Uruguay, Chile, Peru, Ethiopia, British India, St. Vincent, Lagos and Tasmania. 8500 w. Bd of Trd Jour—March, 1898. No. 19305 A.

Tariff Information to be Given by German Customs Authorities. A decree relating to the regulations to come into force April 1st, regarding information as to duties leviable on goods to be imported. 1500 w. Bd of Trd Jour—March, 1898. No. 19304 A.

"Works of Art" in the Tariff. Reports the decision of Judge Townsend, of the U. S. Circuit Court, New Haven, Conn., reversing the decision of the Board of General Appraisers in regard to the church altar, including a tomb and reredos imported into the port of New York, for an Episcopal Church at Binghamton, N. Y. 1000 w. Am Arch—March 19, 1898. No. 19051.

Yangtze-Kiang.

The Trade of Shipping of the Yangtze-Kiang. Reports the value of the import and export trade of this important commercial highway of the Chinese Empire; the use of transit passes, the shipping trade, and tabulated statements of value. 2300 w. Bd of Trd Jour—Feb., 1898. No. 18702 A.

CURRENCY AND FINANCE.

Brazil.

The Brazilian Financial Outlook. An account of the financial difficulties of the last year, and their causes. 1000 w. Bankers' Mag, Lond—March, 1898. No. 18946 A.

Currency Reform.

Suggestions for Currency Reform. J. A. Ayers. A proposition to replace the legal-tender and treasury notes with national bank notes. Relating to the United States. 500 w. Bankers' Mag, N. Y.—March, 1898. No. 18982 D.

Federal Finance.

Seven Years of Federal Finance. Frederick C. Clark. A retrospective study, showing the operation of economic laws, and the disastrous effect of politics, reviewing some of the important events in the United States. 4800 w. Bankers' Mag, N. Y.—March, 1898. No. 18980 D.

Great Britain.

The Financial Relations of England, Scotland, and Ireland. Discusses the contention of Ireland that it was paying more and receiving less than England or Scotland. 2500 w. Bankers' Mag, Lond—March, 1898. No. 18947 A.

International Finance.

The Immorality and Cowardice of Modern Loan-Mongering. A. J. Wilson. Considering a few of the features of "high finance," and discussing some of the probable consequences on the development of modern civilization. 4000 w. Contemporary Rev—March, 1898. No. 19002 D.

Monetary Reform.

Proposed Reform of the Monetary System. J. F. Johnson. A critical examination of two plans recently laid before the United States Congress and known respectively as the Gage plan and the Monetary Commission plan. 12500 w. An Am Acad—March, 1898. No. 18836 H.

Monetary Securities.

Origin and Growth of the Law Governing the Transfer of Monetary Securities. The story of monetary securities and the law governing their transfer; also considers the origin of Great Britain's public debt, rise of the speculative mania, the British consuls, and other related matters. 10000 w. Bankers' Mag, N. Y.—March, 1898. No. 18981 D.

Russia.

Russian Currency Reform. From the official report to the Emperor. Gives an account of the state of the currency, illustrating the present economic condition of the empire, and calls attention to points of importance for the preservation of the currency from future fluctuations. 4500 w. Bankers' Mag, N. Y.—March, 1898. No. 18979 D.

GOVERNMENTAL CONTROL.

Contractors' Rights.

Concerning the Rights of Contractors and Authority of Architects. Decision of the case of Lynch & Woodward against Josiah Quincy *et al.*, as given by Judge Richardson. Of interest to architects, contractors and mechanics. The right to employ non-union laborers. 1700 w. Br Build—Feb., 1898. No. 18711 C.

Legislation.

Political and Municipal Legislation in 1897. E. D. Durand. A study of some of the most noteworthy statutes passed in the United States during the year. 5700 w. *Am Acad—* March, 1898. No. 18835 H.

LABOR.**British Trade Unions.**

What They Propose to Do. Gives proposed demands and propositions. 1000 w. *Engng Mech—* March, 1898. No. 19145 C.

Compensation.

Workmen's Compensation in the Coal Industry. A memorandum issued to the ordinary members of the Lancashire and Cheshire Miners' Permanent Relief Society on the comparative advantages and disadvantages of the Workmen's Compensation Act. 1700 w. *Ir & Coal Trds Rev—* March 11, 1898. No. 19067 A.

Workmen's Compensation in the Coal Trade of Germany. Statistics from the records of the *Knappschafts' Trades' Assn.* with remarks. 1800 w. *Ir & Coal Trds Rev—* March 18, 1898. No. 19183 A.

European Laborers.

Labor Conditions in Europe. A comparison showing the actual condition of things relating to the cost of living among the laboring classes of Europe. 2200 w. *Cons Repts—* March 21, 1898. No. 19068 D.

Inventions.

See Mechanical Engineering, Miscellany.

Japan.

Industrial Japan. Editorial on the industrial development, and the views of Mr. Brennan and Count Okuma. 2000 w. *Engng—* Feb. 25, 1898. No. 18869 A.

Labor Troubles in Japan. Discussing the hard conditions necessarily accompanying the transition from ancient to modern methods. 2400 w. *Gunton's Mag—* March, 1898. No. 18883 C.

Mining Labor.

Capital and Labor in Coal Mining During the Last 200 Years. J. B. Simpson. Extracts from a paper read before the Newcastle (Eng) Economic Society. Reviews the changes and present conditions concluding that the selling price will continue to be the guiding factor for wages. 2800 w. *Col Guard—* March 18, 1898. No. 19176 A.

Strike.

The Late Strike in England. W. H. Booth. Reviewing this labor trouble, its causes and lessons. 3500 w. *Am Mach—* March 17, 1898. No. 19020.

Unemployed.

The Tramp and the Labor Colony in Germany. A. F. Weber. Reviews methods of treatment of this class in various places, giving special account of methods in Germany, the shelters and labor colonies, and suggested methods of reform. 3500 w. *Chau—* March, 1898. No. 18693 C.

Union Label.

The Trade-Union Label. John Graham Brooks. Account of the trade-union label, which seems to be of American origin, the causes for its adoption, and what it stands for. 12000 w. *Bul of Dept of Labor—* March, 1898. No. 19029 D.

MISCELLANY.**Acetic Acid.**

The Manufacture of Acetic Acid. (*La Fabrication de l'Acide Acétique.*) Fr. Miron. Describing the technological details of the process of obtaining acetic acid, methylic alcohol, acetone, creosote, and gaiacol by the distillation of wood. Serial. Part I. 3500 w. *La Revue Technique—* March 10, 1898. No. 19210 D.

American Fruits.

Germany's Exclusion of American Fruits. John B. Smith. Considers the orders issued by Germany, forbidding the introduction of fruits or living plants without having been previously inspected, and shows that the steps taken by the U. S. government uphold the fact that danger of infection from San José scale must be guarded against. 2200 w. *N Am Rev—* April, 1898. No. 19360 D.

Hard Rubber.

Development of the Hard Rubber Industry. Gives the history of the hard rubber industry in the United States, with interesting notes relating to accidents which led to important inventions. 3600 w. *Ind Rub Wld—* April 1, 1898. No. 19306 D.

Mexico.

Finances and Industries of Mexico. Statements of the estimates for the fiscal year 1898-99, presented in Dec. last to the Mexican House of Deputies. 1800 w. *Cons Repts—* March 3, 1898. No. 18795 D.

Patents.

The Protection of Industrial Property. J. F. Iselin. Considers, from an international point of view, the protection of patents, trade marks, designs, and other rights of the same kind. Gives history of protection of these rights in England. Also discussion. 5400 w. *Jour Soc of Arts—* Feb. 18, 1898. No. 18720 A.

Rubber Manufacture.

Rubber Manufacture by South American Natives. Information of practices among the natives, seeming to have originated among themselves, but which involve principles of importance in the development of rubber. Ill. 2000 w. *Ind Rub Wld—* March 10, 1898. No. 19049 D.

Trusts.

A New Voice on Trusts. Extracts from an address of Mr. Alfred Dolge at the annual reunion held at Dolgeville, N. Y., showing the benefits that arise to all mankind, from combination. 3000 w. *Gunton's Mag—* March, 1898. No. 18881 C.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bleaching.

Bleaching by Electricity. (Die Elektrische Bleiche.) H. Wartner. Discussing the bleaching of cotton goods by means of chlorine solutions produced by electrical decomposition, with data of the commercial results obtained in Germany and in Russia. 1200 w. *Elektrochemische Zeitschr*—March, 1898. No. 19274 D.

Electro-Chemical Products.

The Manufacture of Electro-Chemical Products. An account of the methods adopted in the works of the Electro-Chemical Co., of St. Helens, where caustic soda, bleaching powder and chlorate of potash are manufactured. Ill. 2000 w. *Elec Rev*, Lond—March 11, 1898. No. 19075 A.

Electro-Deposition.

On Some Recent Investigations in Connection with the Electro-Deposition of Metals. J. C. Graham. Communicated to the Royal Society. Experiments appearing to give some light regarding the conditions necessary for the rapid deposition of metals from their solutions by mean of the electric current. 1000 w. *Elec Rev*, Lond—Feb. 25, 1898. Serial. 1st part. No. 18846 A.

Electrolysis.

Studies in the Electrolytic Decomposition of Aqueous Solutions. (Studien über die Elektrolytische Zersetzung Wässriger Lösungen.) L. Glaser. The beginning of an elaborate discussion, starting with the theory of the H. O. chain, and proceeding to the decomposition of water and of solutions. Serial. Part 1. 2500 w. *Zeitschr f Elektrochemie*—Feb. 5, 1898. No. 19276, each H.

The Electrolytic Separation of Gold. (Ueber Goldscheidung auf Elektrolytischem Wege.) Dr. E. Wohlwill. A general discussion of the chemical reactions in connection with the electrolytic separation of gold from solutions of chloride or of cyanide. Serial. Part 1. 4000 w. *Zeitschr f Elektrochemie*—Feb. 20, 1898. No. 19277, each H.

Hulin Process.

The Hulin Electrolytic Alkali Process. John B. C. Kershaw. An account of the experiments and development of this process, with statement of its advantage. 1500 w. *Elect'n*, Lond—March 4, 1898. No. 18965 A.

Reflectors.

An Electrolytic Process for the Manufacture of Parabolic Reflectors. Sherard Cowper-Coles. Read before the British Institution of Elec. Eng. Describes the process, one of the chief features being that the surface produced requires no after polishing. Ill. 2500 w. *Elec Eng*, Lond—Feb. 18, 1898. No. 18726 A.

LIGHTING.

British Columbia.

Municipal Electric Light Plant at New West-

minster, B. C. Brief account of the works and the returns. 1200 w. *Can Elec News*—March, 1898. No. 18873.

Central Stations.

Central Station Accessories. Part first is introductory, defining the scope of the articles to follow. They will deal with feed-water appliances, boiler appliances, feed-water heating and purifying, draining, condensing, lifting, &c. 1700 w. *Elec*, Lond—March 4, 1898. Serial. 1st part. No. 18971 A.

Delta, Pa.

Delta Light and Power Plant. Illustrated description of the water-power electrical generating plant of Delta, York Co., Pa. 1500 w. *Am Elect'n*—March, 1898. No. 18830.

Enclosed Arcs.

A Novel High-Tension Series Enclosed Arc System. J. H. Hallberg. Considers the requirements of the enclosed arc lamp for high-tension series, street lighting and commercial circuits, and calling attention to their advantages. 2200 w. *Elec Rev*, N. Y.—March 23, 1898. No. 19079.

Filaments.

Incandescent Lamp Filaments. Jno. C. Shedd. Reviews the early difficulties met with in this field and the solving of the problem. 1500 w. *Am Elect'n*—March, 1898. No. 18832.

Headlights.

See Railway Affairs, Equipment.

Higher Pressure.

Electricity Supply at Higher Pressure. Deals with the difficulties which have arisen from increasing the maximum voltage at which current is delivered, considered mainly from the consumer's point of view. 2500 w. *Arch*, Lond—March 11, 1898. No. 19073 A.

Hospital Lighting.

The Electric-Lighting Plant of the Boston City Hospital. H. W. Weller. Illustrated detailed description. 2200 w. *Elec Eng*, N. Y.—March 31, 1898. No. 19196.

Illumination.

Dr. Bunte on Incandescent Lighting, Acetylene, and the Development of Flame Illumination. Abstract translation of lecture at Leipsic, before the German Assn. of Gas and Water Eng. Deals with the developments of flame illumination during the last twenty years. 3000 w. *Jour Gas Lgt*—Feb. 22, 1898. Serial. 1st part. No. 18755 A.

Incandescent Lamps.

The Temperature of Incandescent Lamps. (Sur la Temperature des Lampes à Incandescence.) A paper by M. Janet giving the methods used for measuring the temperatures of the filaments. Tests of 4 lamps of 10 candle power at 65 volts gave temperatures between 1610° to 1720° C. 1200 w. *Comptes Rendus*. March 7, 1898. No. 19227 D.

Lamp Resistance.

A New Method of Determining the Resistance of Incandescent Electric Lamps. (Ueber Eine Neue Methode zur Bestimmung des Elektrischen Leitungswiderstandes Stromdurchflossender Glühlampen.) Drs. Apt and Hoffmann. A combination of two Wheatstone bridges and balancing resistances by means of which the resistance of incandescent lamps may be determined while the current is flowing. 2500 w. *Elektrotech Zeitschr*—Feb. 24, 1898. No. 19266 B.

London Stations.

London Electric Light Stations. Herbert C. Gunton. An analysis of some of the most important and representative systems, illustrating the methods of operation and the plant employed. Part first considers the system of the London Electric Supply Corporation. Ill. 2000 w. *Elec Wld*—March 5, 1898. Serial. 1st part. No. 18791.

Municipal Lighting.

Practical Hints on Starting a Municipal Electrical Department. J. J. Steinitz. Extracts from a paper read before the Falcon Works Engineering Society. Discusses the difference between a municipal and a company undertaking the work of a municipal electric engineer, &c. 3700 w. *Elect'n, Lond*—Feb. 18, 1898. No. 18738 A.

N. Y. Post Office.

The Lighting of the New York Federal Building. Illustrated description of the isolated plant lately installed in the United States custom house and post-office in New York. 1400 w. *Elec Wld*—March 26, 1898. No. 19097.

Rates.

Rates for Incandescent Lighting. E. L. Wells, Jr. Abstract of paper read at the joint meeting of the Texas and Mexican electrical associations, Laredo, Tex. Brief discussion of the two general methods of charging, and their modifications. 1000 w. *Elec Wld*—March 19, 1898. No. 19001.

Room Lighting.

Experiments in Room Illumination. I. C. Thompson. Gives an illustrated account of tests made to determine whether a room was sufficiently lighted. 1500 w. *Elec Eng, N. Y.*—March 17, 1898. No. 19004.

Small Town Plant.

The Electric Light Plant in the Small Town. Its Resources and Chances for Extension. J. R. Cravath. Suggestions to owners of plants in towns of two to five thousand inhabitants of the possibilities for increasing business. 2000 w. *Elec Eng, N. Y.*—March 10, 1898. No. 18901.

Spain.

Electrical Engineering in Spain: The Electric Lighting of Mazarron. Illustrated description of the system. 900 w. *Elect'n, Lond*—Feb. 25, 1898. No. 18863 A.

Switchboards.

Central Station Switchboards. F. A. C. Perrine. Extracts from a paper read before the San Francisco convention of the Pacific Coast Elec. Trans. Assn. Considers the material for

the board, the circuits and the insulation employed, instruments installed and location. 2200 w. *Elec Wld*—March 26, 1898. No. 19098.

Toronto, Canada.

The New Works of the Toronto Electric Light Company. Illustrated description. 1200 w. *Can Elec News*—March, 1898. No. 18872.

200-Volt Circuits.

On the Manufacture of Lamps and Other Apparatus for 200-Volt Circuits. G. Binswanger Byng. Read before the Inst. of Elec. Engs., England. Describes the appliances now upon the market, or under manufacture, pointing out deficiencies, and giving writer's views. 2800 w. *Elec Rev, Lond*—Feb. 25, 1898. Serial. 1st part. No. 18845 A.

Wiring.

Free Wiring Systems. John H. Rider. Report to the Electricity Committee of Plymouth Corporation. Presents the methods of the Free Wiring Syndicate, Limited, and the advantages of the scheme. 1500 w. *Elec Eng, Lond*—March 18, 1898. No. 19156 A.

POWER.**Booster.**

See Street and Electric Tramways.

Commutators.

See Street and Electric Tramways.

Crane.

See Mechanical Engineering, Shop & Foundry.

Dredges.

Electrically Operated Power Dredges. Illustrated description of machinery for mining developed by the Bennett Amalgamator Manufacturing Co. 2000 w. *Elec Wld*—March 5, 1898. No. 18788.

Eddy Currents.

Losses Due to Eddy Currents in the Pole Pieces of Electric Machines. William Baxter, Jr. Explains the cause of the difficulty and the best way to avoid it. Ill. 1700 w. *Am Mach*—March 17, 1898. No. 19021.

Electrical Generation.

The Steam Engine and the Dynamo—A Chapter in Evolution. Charles T. Child. A review of the reciprocal development of the engine and the dynamo in response to the demands of power-house practice. Each machine has acted to produce an improvement in the other. 3500 w. *Engineering Magazine*—April, 1898. No. 19297 B.

Electric Locomotive.

See Railway Affairs, Motive Power.

Fly-Wheel Dynamo.

M. Patin's New Fly-Wheel Dynamo. Illustrates and describes a somewhat novel type of dynamo in use in Paris. 800 w. *Engr, Lond*—March 18, 1898. No. 19166 A.

Hamburg.

The Electric Plant at the Hamburg Customs Warehouses. (Das Elektrizitätswerk an der Zollvereinsniederlage zu Hamburg.) J. H.

Kinbach. A full description of this important plant, with data of tests of the engines. There are five triple-expansion vertical Corliss engines, of 1200 h. p. each, directly connected to the generators. Atmospheric condensers with cooling towers are used, 5000 w. 1 plate. *Zeitschr d Ver Deutschr Ing*—March 12, 1898. No. 19253 D.

Mexico.

Notes on Mexico. (Notes sur le Mexique.) Ramon Fernandez de Arteaga. Especially describing the development of hydraulic power in the numerous mountain streams including the hydraulic electric power station at Régla, near Pachuca. 2500 w. *Le Génie Civil*—Feb. 19, 1898. No. 19212 D.

Mining Machinery.

See Mining and Metallurgy, Mining.

Monocyclic System.

Successful Monocyclic Power Distribution at Middletown, Ohio. An example of the introduction of this system into a direct-current station. Ill. 1000 w. *Elec Eng, N. Y.*—March 31, 1898. No. 19199.

Motor Design.

Considerations Governing the Design of the Crocker-Wheeler Direct-Connected Motors. Gano S. Dunn. Description of the construction adopted with a view to obtaining the desired output without too great an increase of size. Ill. 800 w. *Elec Eng, N. Y.*—March 31, 1898. Serial. 1st part. No. 19198.

Munich.

The New Electric Station at Munich. (Die Neuen Elektrizitätswerke Münchens.) F. Upenborn. A general description of this important plant, with plans of the buildings and a map of the city showing the location of the five substations with regard to the main power plant. 5000 w. *Elektrotech Zeitschr*—March 3, 1898. No. 19268 B.

Polyphase Motors.

See Street and Electric Tramways.

Power Plant.

The Butte, Montana, Power Plant. Illustrated description of a 6000 H. P. hydro electric plant with steam relay and a 66-ft. timber dam. 900 w. *Eng Rec*—March 5, 1898. No. 18893.

The Dolgeville, N. Y., Electric Light and Power Plant. Data and illustrations of a plant for the generation of electricity for lighting, heating, &c. 1800 w. *Elec Eng, N. Y.*—March 17, 1898. No. 19003.

The Electric Power Plants in Reading, Pa. N. Monroe Hopkins. Illustrated description of the combined power plant of the Metropolitan Electric Co. and the United Traction Co. 2000 w. *Elec Eng, N. Y.*—March 10, 1898. No. 18900.

The Saint Anthony Falls Power Plant. Edward N. Saunders, Jr. Brief account of this plant built to furnish power for the street railways of St. Paul and Minneapolis. Ill. 1800 w. *Yale Sci M*—Feb., 1898. No. 18690 C.

Sparkling.

Sparkling, Its Cause and Effects. Thorburn

Reid. Shows that the real injury is done before the segment leaves the brush, and discusses some of the ways in which imperfect commutation causes injury to the commutator, and how sparkless commutation may be assured. Discussion. 10000 w. *Trans Am Inst of Elec Eng*s—Jan., 1898. No. 19008 D.

Starting.

A Simple Method of Starting Single Phase Alternating Current Motors. (Ein Einfaches Verfahren, um Asynchrone Einphasige Wechselstrommotoren zum Anlauf zu Bringen.) Riccardo Arno. Describes the use of an auxiliary resistance in connection with the armature. 2000 w. *Elektrotech Zeitschr*—Feb. 17, 1898. No. 19265 B.

Towing.

The Development of Electric Cableways. Richard Lamb. An illustrated account of the electric cableways, and their application to canal-boat towing. Also other uses to which they may be applied. Discussion. Ill. 11500 w. *Trans Am Inst of Elec Eng*s—Jan., 1898. No. 19007 D.

Transmission.

The Newcastle-Sacramento Transmission. Illustrated description of one of the most interesting installations in the western part of the United States. 3300 w. *Jour of Elec*—Feb., 1898. No. 19252.

The Harnessing of the Missouri River Near Helena, Montana. Illustrated description of the latest installation in the Rocky Mountain region. 700 w. *Elec Eng, N. Y.*—March 31, 1898. No. 19197.

TELEGRAPHY AND TELEPHONY.

Cables.

A Graphical Method of Determining the Current in Submarine Cables. (Ueber ein Graphische Methode um den Stromverlauf in Unterseeischen Kabeln Darzustellen.) F. Rossel. The impulses are plotted graphically and the combination of the successive diagrams enables the entire current to be shown. 2000 w. *Elektrotech Zeitschr*—March 3, 1898. No. 19270 B.

The Empire and the Telegraph Cables. Discussing the subject of a system of submarine cables starting from England, and carried to various British possessions. 1100 w. *Elec Rev, Lond*—March 4, 1898. Serial. 1st part. No. 18969 A.

Construction.

Art of Constructing Telephone Apparatus. H. P. Clausen. A general review of what is being done by builders of telephone appliances. Ill. 3800 w. *W Elect'n*—Feb. 26, 1898. No. 18747.

Exchange.

Fort Wayne Telephone Exchange. Illustrated description. 700 w. *W Elect'n*—Feb. 26, 1898. No. 18746.

Measurement.

The Measurement of the Electrical Properties of Telephone Lines. Dr. V. Wietlisbach. Mathematical investigations. 900 w. *Elec Engng*—March 1, 1898. No. 18794.

Modern Telephones.

The Modern Telephone Instrument. Francis G. Hall, Jr. Describes the long-distance instrument. Ill. 2400 w. Yale Sci M—Feb., 1898. No. 18692 C.

Operation.

The Telephone Situation. J. J. Nate. Presents the various phases of the work, discussing the organization methods, equipment and exchange operation in part first. 2400 w. W Elect'n—March 12, 1898. Serial, 1st part. No. 18942.

Stockholm.

The Underground Telephone System in Stockholm. (Die Unterirdische Fernsprechanlage in Stockholm.) A Hultman. A general description of the system. The wires are drawn through holes in insulating blocks. Two articles. 5000 w. Elektrotech Zeitschr—Feb. 17, 24, 1898. No. 19263 each B.

Synchronograph.

Tests of the Synchronograph on the Telegraph Lines of the British Government. Albert Cushing Crehore and George Owen Squier. Gives a brief description of the Wheatstone instruments, and of the experiments made. Ill. 4500 w. Jour Fr Inst—March, 1898. Serial, 1st part. No. 18808 D.

Telephone Work.

Practical Features of Telephone Work. A. E. Dobbs. Suggestions for starting a new exchange, and the importance of having the advice of a competent superintendent who has had practical experience, are given in part first. 1800 w. Elec Eng, N. Y.—March 17, 1898. Serial, 1st part. No. 19005.

Telephote.

The Telephote. J. Warren. An instrument devoted to picture telegraphy. Its essential feature is a selenium cell, and the article considers mainly the nature and properties of this substance. 1400 w. Elec, Lond—Feb. 25, 1898. No. 18843 A.

MISCELLANY.**Accidents.**

Death by Electricity. W. S. Hedley. A study of the causes that produce death by electricity with account of experiments on animals. 2000 w. Elec Rev, Lond—Feb. 18, 1898. No. 18735 A.

Accumulators.

The Dependence of the Electromotive Force and Efficiency of Accumulators upon the Strength of Acid. (Ueber die Abhängigkeit der Elektromotorischen Kraft und der Nutzefectes des Bleiakkumulators von der Säurekonzentration.) F. Dolezalek. A mathematical discussion, the conclusions of which are confirmed by experimental tests. 3500 w. Zeitschr f Elektrochemie—Feb. 5, 1898. No. 19275 H.

Coil Winding.

Hints on the Windings of Magnet Coils. William Baxter, Jr. Shows that the greatest danger comes from attempts to crowd too many

turns in a layer, and illustrates various defects. 1600 w. Am Mach—March 3, 1898. No. 18783.

Columbia University.

Electrical Engineering of Columbia University. F. B. Crocker. A description of the new buildings and their equipment. Ill. 2200 w. Elec Wld—March 12, 1898. No. 18899.

Diagrams.

Standard Diagrams for Uniformity in Electrical Engineering and Patent-Office Drawings. Diagrams approved and adopted by the Chicago Electrical Assn., Feb. 4, 1898. 1600 w. Elec Rev, N. Y.—March 2, 1898. No. 18752.

Disruptive Discharges.

On the Disruptive Discharge in Air and Liquid Dielectrics. T. W. Edmondson. Gives history of work in this field and describes experiments made, giving tabulated results. Ill. 4400 w. Phys Rev—Feb., 1898. No. 19030 D.

Photographic Investigation of 150,000-Volt Power Discharge. Charles Proteus Steinmetz. Investigation of the phenomena taking place during a disruptive discharge at a very high voltage and in a circuit of sufficient power to maintain an arc. Ill. 2200 w. Elec Wld—March 5, 1898. No. 18789.

Electrical Science.

The Development of Electrical Science. Thomas Gray. Address of the president, delivered before the annual meeting of the Indiana Academy of Sciences. 10300 w. Science—March 18 and 25, 1898. 2 parts. No. 19032 C.

Electro-Dynamics.

The Study of Electro-Dynamics. J. Warren. Considers each of the laws and phenomena propounded by Ampere relating to the action of active conductors upon one another. Ill. 1500 w. Elec, Lond—March 4, 1898. Serial. 1st part. No. 18972 A.

Electrometer.

The Kelvin Quadrant Electrometer as a Wattmeter and Voltmeter. Ernest Wilson. Gives the experience which the writer has gained with this instrument. 2000 w. Elec Rev, Lond—March 4, 1898. Serial. 1st part. No. 18970 A.

Galvanometer.

Practical Work with the Ballistic Galvanometer. Lawford H. Fry. Describes methods which facilitate work with this instrument. 1700 w. Elec Rev, Lond—March 4, 1898. No. 18968 A.

Hysteresis.

A Method of Determining Magnetic Hysteresis Loss in Straight Iron Strips. J. A. Fleming. Read before the Physical Society. Description of a process which is based upon the use of the bifilar reflecting wattmeter, and operates on samples of iron large or small, in the form of straight strips which are simply slipped into a long magnetizing coil. Ill. 2000 w. Elect'n, Lond—Feb. 25, 1898. Serial. 1st part. No. 18864 A.

Magnetism.

The Analogy of Action between Luminous Rays and Lines of Magnetic Force. (Sur une

Analogie d'Action entre les Rayons Lumineux et les Lignes de Force Magnetique.) A paper presented to the French Academy by M. Birke-land discussing some remarkable experiments made with a Crookes tube in a strongly magnetic field. The results are tabulated and shown in diagrams. 1800 w. Comptes Rendus—Feb. 21, 1898. No. 19225 D.

Toronto Magnetic Observatory. The history of the establishment, and report of the troubles arising from recent electric light circuits, electric cars, iron-frame buildings, &c. 1400 w. Can Eng—March, 1898. No. 18986.

Magnets.

Magnet Winding Curves. J. P. Stone. Gives curves by use of which the calculation of the space required for the winding is greatly facilitated. 500 w. Elec Eng, N. Y.—March 24, 1898. No. 19100.

Nickel Steel.

Investigations into the Magnetic Properties of Nickel Steel. (Recherches sur les Propriétés Magnétiques des Aciers au Nickel.) A paper by M. Eugene Dumont giving the magnetic permeability of various alloys at different temperatures. 1000 w. Comptes Rendus—March 7, 1898. No. 19229 D.

Oils.

On the Specific Inductive Capacity of Certain Oils. Arthur L. Clark. Describes investigations made by the use of Quincke's bubble method, giving results. 900 w. Phys Rev—Feb., 1898. No. 19031 D.

Resistance.

The Measurement of Fault Resistances with a Voltmeter. Stuart A. Russell. Describes several applications of the use of the voltmeter and calls attention to the results that may be obtained. 1800 w. Elec Rev, Lond—Feb. 25, 1898. No. 18844 A.

The Precise Comparison of Very Small Resistances. Samuel Sheldon. Outlines a method used with great success at the Polytechnic Institute for determining low resistances. Ill. 900 w. Elec Wld—March 5, 1898. No. 18790.

Supervision.

An Electrical Bureau. William Brophy. Address delivered before the International Assn. of Commissioners and Inspectors of Buildings, held at Detroit, Mich. On the advisability of organizing and maintaining such bureaus for the protection of life and property. 2100 w.

Arch & Build—March 12, 1898. Serial. 1st part. No. 18921.

Switch.

Some Switch Devices for Laboratory Use. (Einige Schaltapparate für den Laboratoriums-gebrauch.) Dr. J. Kollert. Describing a form of revolving commutator, and various applications of it to laboratory work. 2000 w. Elektrotech Zeitschr—March 3, 1898. No. 19269 B.

Testing.

A 100,000-Volt Testing Set. C. E. Skinner. Gives general plan of apparatus made by the Westinghouse Electric & Manufacturing Co., for the Cataract Construction Co. of Niagara Falls, by means of which tests may be made at any E. M. F. from 1200 volts to 100,000 volts. Ill. 1800 w. Elec Wld—March 5, 1898. No. 18792.

Thermo-Electricity.

Contributions to the Thermoelectric Problem. (Zum Thermoelektrischen Problem.) A. Wilke. An examination of the action of heat upon the electrical state of a homogeneous body, in connection with the observations of Hall, v. Ettinghausen, and Nernst. 3500 w. Deutsche Zeitschr f Elektrotechnik—Jan. 15, Feb. 1, 1898. No. 19271 each E.

Transformer.

Separation of the Iron Losses of a Transformer. H. S. Carhart. A method based on the measurement of these combined losses at two frequencies. 600 w. Elec Wld—March 5, 1898. No. 18793.

Warfare.

Manifold Uses of Electricity in Time of War. From the *Boston Transcript*. Discusses the urgency of the formation of an electrical corps for the army and navy, as electrical devices are unfamiliar to any but trained experts. 1800 w. Bos Jour of Com—March 26, 1898. No. 19123.

X-Rays.

A Theory in Reference to the Origin and Character of X-Rays. George Adam. An attempt to account for the rays by the atomic theory. 1000 w. Elec Rev, N. Y.—March 9, 1898. No. 18885.

Remarks upon X-Ray Tubes. C. C. Hutchins. A review of the experiments that have been made in this field. 1500 w. Elec Rev, N. Y.—March 16, 1898. No. 18989.

MARINE ENGINEERING.

Ballasting.

The Ballasting of Steamers. Editorial on a resolution discussed in the House of Lords having for its object the regulation of the ballasting of steamers. The dangers of navigation in ballast are considered. 1700 w. Engr, Lond—Feb. 25, 1898. No. 18860 A.

Battleships.

British and Foreign Types of Battleships. Editorial calling attention to some features in the most important types of warships. 900 w.

Engr, Lond—March 18, 1898. No. 19165 A.

Destruction of the U. S. Battleship Maine by an Explosion in Havana Harbor. Technical information of the construction and equipment of this vessel, with engravings illustrating the warship and her machinery. 8500 w. Marine Engng—March, 1898. No. 18916 C.

Boiler Furnaces.

The Causes of Collapse in Marine Boiler Furnaces. William R. Austin. Read before the Inst. of Engs. and Shipbuilders, Scotland.

States the known and assumed causes and gives a theory which the writer thinks may account for some unexplained cases. Ill. 3000 w. *Prac Eng*—March 4, 1898. No. 18984 A.

Cruiser.

The Spanish Cruiser "Cristobal Colon." Illustrated description with some interesting explanations relating to the rapid work. 2000 w. *Engng*—Feb. 18, 1898. No. 18729 A.

High Pressures.

High Pressures at Sea with Some Consideration of Types of Boilers. W. R. Cummins. From a paper read at the North-East Coast Inst. of Engs. & Shipbuilders, in Sunderland, England. Considers the theoretical economy of steam, and the type of boiler best suited to the new conditions. 2000 w. *Marine Engng*—March, 1898. Serial. 1st part. No. 18917 C.

Loading.

An Essay upon Methods of Loading. (Essai sur des Procédés d'Arrimage.) Devoted to the proper method of loading vessels with rails, and arranging cargo so as to avoid shifting; including the loading of wooden and iron ships and also iron steamers. Serial. Part I. 4000 w. *La Revue Technique*—March 10, 1898. No. 19209 D.

Navigation.

Bech's Apparatus for Controlling the Course of a Vessel. (Der Bech'sche Schiffscurs-Controllapparat.) A combination of compass and photographic recording apparatus by means of which any deviation of a vessel from a given course is recorded and shown. 3500 w. *Oesterr Monatschr f d Oeffent Baudienst*. No. 19283 D.

Navy Estimates.

The Navy Estimates. Reviews the work for the coming year, the annual statement for last year, estimates and general matters connected with the navy. 2500 w. *Engng*—March 11, 1898. No. 19060 A.

Propulsion.

Propulsive Power. James N. Warrington. A comparison of the results of speed trials of several new ships, with explanation and tabulated calculations. 1200 w. *Jour Am Soc of Nav Engs*—Feb., 1898. No. 18823 H.

Rapid Construction.

Speed of Construction, a Vital Factor of Naval Strength. Frank B. King. Urging simplification of hull, machinery, fittings and armament, and other changes allowing economy of time. The application of the "unit principle," and changes tending to rapid building. 4800 w. *Jour Am Soc of Nav Engs*—Feb., 1898. No. 18827 H.

River Boats.

Steamboats for the Yukon Trade. Describes boats designed and built by Lewis Nixon to ply on the rivers of Alaska and South America, of interest because of their carrying capacity, light draft, and original features of design. Ill. 1200 w. *R R Gaz*—March 25, 1898. No. 19114.

The Modern Ohio River Boat. Hunter Morrison. Showing the improvements made in

river boats and describing the "Queen City" owned by the Pittsburgh & Cincinnati Packet line. Ill. 2000 w. *Yale Sci M*—March, 1898. No. 19014 C.

Shipbuilding.

An American Menace to British Shipbuilding. Editorial on an article by Andrew Carnegie in the *Iron Trade Review*, of Cleveland, urging the United States to regain the supremacy in shipbuilding. 1100 w. *Ir & Coal Trds Rev*—March 18, 1898. No. 19182 A.

German Shipping and Shipbuilding. Discusses the progress made, the development of the merchant marine, the sailing fleet, shipbuilding, &c. 2500 w. *Engng*—March 18, 1898. No. 19172 A.

How a Ship is Made. Max Hahn. Considers the construction of a modern ocean steamer. 1800 w. *Chau*—April, 1898. No. 19185 C.

Shipbuilding in 1897. Calls attention to the discrepancies found in published reports of various papers, and of Lloyd's Register, showing that it is useless to try to be very precise in reporting statistics. Gives general information of the amount of work done in British shipyards. 3000 w. *Engr, Lond*—Feb. 18, 1898. Serial. 1st part. No. 18721 A.

War-Ships Building on the Delaware. Henry Starr Richardson. Illustrations of the "Princeton," "Mackenzie," "Alabama" and "Kasagi," with brief remarks. 500 w. *Harper's Wk*—April 2, 1898. No. 19187.

Ship Power Plants.

See Mechanical Engineering, Transmission.

Steam Consumption.

Steam Consumption of the Main and Auxiliary Machinery of the U. S. S. Minneapolis. W. W. White. Prize essay. Full description of the apparatus for testing, the methods adopted, with tabulated results, discussion and plates. 3000 w. *Jour Am Soc of Nav Engs*—Feb., 1898. No. 18822 H.

Steamship Construction.

Recent Designs in Steamship Construction upon the Great Lakes. Richard L. Newman. Some of the difficulties are discussed, the position of machinery, the midship sections, &c. Discussion. Ill. 5400 w. *Jour Assn of Engng Socs*—Jan., 1898. No. 18697 C.

Submarine Boat.

Holland Submarine Boat. An illustrated descriptive article dealing with the main features of the boat which was invented by John P. Holland. 1800 w. *Engr, N. Y.*—March 15, 1898. No. 19009.

Trials.

Gun and Steam Trials of H. M. S. "Illustrious." An account of the trials which mark a distinct advance as a consequence of the introduction of many mechanical devices. 2000 w. *Engng*—March 18, 1898. No. 19171 A.

Speed and Power Trials of a Light-Draught Steam Launch. Charles Ward. Describes the boat and trials, giving tabulated results. 2500 w. *Jour Am Soc of Nav Engs*—Feb., 1898. No. 18829 H.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Furnaces.

See Marine Engineering.

Boiler Tests.

Boiler Testing with Various Fuels. David P. Jones. The writer has given this subject much attention and presents some of the results of his experience, with suggestions as to what may be the best methods to secure the best results. Ill. 7800 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18826 H.

Tests of a Corrugated Furnace "Gunboat Type" Boiler. Notes some of the features of the boiler and reports test, which gives results of more than usual interest. 1100 w. Eng News—March 3, 1898. No. 18771.

Test of Internally Fired Boiler at the Washington Mills. Gives the data of a test, noteworthy for the rapid combustion and high results obtained. 500 w. Eng Rec—March 5, 1898. No. 18894.

Trials of the Niclausse Safety Water-Tube Boiler. Jay M. Whitham. Illustrated description, dimensions of boiler, manner of testing, object and results. Also discussion. 6300 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18825 H.

Chimney.

See Architecture and Building, Construction.

Circulation.

A Study of the Circulation of Water in Multitubular Boilers. (Etude de la Circulation de l'Eau dans les Chaudières Multitubulaires.) H. Brillié. A mathematical and experimental treatment, especially relating to the nature and causes of circulation in water-tube boilers. Four articles. 10000 w. Le Génie Civil—Feb. 19, 26, March 5, 12, 1898. No. 19213 each D.

Combustion.

The Schlicht Method of Combustion. P. J. Schlicht. Describes the plan and reports practical results of this system. Ill. 1800 w. Elec Eng, N. Y.—March 17, 1898. No. 19006.

Furnace Gases.

The Econometer: A Gas Balance for Indicating Continuously the Proportion of Carbonic Acid Gas in the Flow of Furnace Gases. Report of the Institute, through its Committee on Science and the Arts, investigating the invention of Max Arndt, of Aix-la-Chapelle. Illustrates and describes the apparatus, and considers that its claims have been fully substantiated. 2500 w. Jour Fr Inst—March, 1898. No. 18811 D.

Grease Extractors.

The Location of Grease Extractors. William R. Billings. A criticism of statements made in editorial of this paper, giving the writer's experience. 900 w. Eng Rec—March 5, 1898. No. 18892.

High Pressures.

Some of the Practical Difficulties of the

Higher Pressures. E. Richards. Reviews some of the difficulties that have had to be met by modern engineers, and details that require attention before future advance may be expected. 3300 w. Prac Eng—Feb. 25, 1898. No. 18839 A.

See Marine Engineering.

Incrustation.

Steam Boiler Incrustation. Recommending the use of sodium tannate. 800 w. Power—March, 1898. No. 18880.

Injectors.

Locomotive Injectors. George H. Baker. History of the invention and early use of injectors, with a discussion of its advantages over the pump, and the best injectors for locomotive service. 3000 w. Ry Mag—Jan., 1898. No. 18758.

Low Water.

Low Water in a Steam Boiler. (Manque d'Eau dans un Générateur de Vapeur.) C. Walckenaer. A discussion of a boiler explosion at Montreuil-sous Bois, with an account of experimental investigations into the causes of sudden fluctuations of water level and disappearance of water from the glass. 4000 w. I plate. Annales des Ponts et Chaussées, 3 Trimestre, 1897. No. 19237 F+G.

COMPRESSED AIR.

Efficiency.

Doubling the Efficiency of Compressed Air. Frank Richards. Presents a scheme for the more economical use of compressed air. 1800 w. Am Mach—March 24, 1898. No. 19095.

Gwin Mine.

Compressed Air at the Gwin Mine. E. A. Rix. From the Golden Jubilee edition of "The Mineral Resources of Calaveras County," California. Illustrates and describes an interesting and economic installation. 1700 w. Jour of Elec—Feb., 1898. No. 19053.

Indicator Diagrams.

The Analysis of Air-Compressor Indicator Diagrams. F. A. Halsey. Analysis of card submitted by a correspondent, with reply to questions asked. 1600 w. Am Mach—March 3, 1898. No. 18782.

Pneumatic Tools.

Shop Tools Driven by Compressed Air. Aiming to show the number and variety of tools which are now driven by compressed air. 700 w. Am Mach—March 24, 1898. Serial, 1st part. No. 19094.

The Boyer Hammer. Illustrated description of a pneumatic hammer, used for caulking, chipping, beading tubes, and other purposes. 4000 w. Engng—Feb. 25, 1898. No 18871 A.

Riveters.

See Shop and Foundry.

Rolling Mill.

Compressed Air in a Rolling Mill. Harry

M. Perry. Illustrated description of some of the applications at the Passaic Rolling Mill Co. of Paterson, N. J. 1000 w. Compressed Air—March, 1898. No. 19105.

ENGINES AND MOTORS.

Air Pump.

Vertical Air Pumps without Suction Valves. (Betrachtungen über die Stehenden Kondensator-Luftpumpen ohne Saugventile.) Karl Reinhardt. A mathematical discussion of an improved form of air pump for condensing engines. A very simple and effective design. 5000 w. Zeitschr d Ver Deutscher Ing—March 5, 1898. No. 19251 D.

Blowing Engines.

Notes on Blowing Engines. T. M. Grant. Abstract of paper read before the West of Scotland Iron & Steel Inst. Describes various types. 2300 w. Engr's Gaz—March, 1898. No. 18945 A.

Condensers.

Improved Condenser Installations. (Neuere Kondensationsanlagen.) A fully illustrated article showing existing installations of the Klein surface condensers with cooling towers. 1200 w. Glaser's Annalen—Feb. 15, 1898. No. 19279 D.

Diesel Motor.

The Diesel Motor. E. D. Meier. Reviews work of many mechanical engineers aiming to develop a perfect heat engine, and discusses the degree of success attained by each. Gives the principles of the Diesel motor, the results of tests made, and interesting general information. 7500 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18828 H.

The Diesel Motor. E. D. Meier. Some account of the work done in thermodynamics, especially the careful work of Rudolph Diesel, stating what the writer considers the underlying principle of this invention, and giving a short description of the motor as thus far developed. Ill. 1400 w. Jour Assn of Engng Socs—Jan., 1898. No. 18698 C.

The New Diesel Motor. (Diesel's Neue Wärmemotor.) A paper by Fritz Krauss, discussing the performance and theory of the Diesel motor in comparison with other heat engines. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—March 11, 1898. No. 19261 B.

Gas Engines.

Gas-Engine Research. Report of Frederic W. Burstall to the Gas-Engine Research Committee of the Inst. of Mech. Engs., England. Experiments to determine the effect produced on the economy of gas-engines by altering one or more of the conditions governing their working. Also discussion. 5200 w. Jour Gas Lgt—Feb. 22, 1898. No. 18756 A.

The Gas Engine in American Practice. George Richmond. Showing how the original devices imported from Europe have been modified by American builders and reviewing the present condition of gas engine practice in the United States. 4000 w. Engineering Magazine—April, 1898. No. 19298 B.

The Use of Lean Gases in Gas Engines. M. Lencauchez. Read before a session of the Société de l'Industrie Minérale. Reports conclusions from tests made at the Hoerde (Westphalia) Iron Works, and gives further information. 1500 w. Pro Age—March 15, 1898. No. 18994.

Governors.

The History of the Shaft Governor. Investigation of the subject, with illustrations. 2000 w. Eng News—March 17, 1898. No. 19024.

Keely Motor.

The Keely Motor. E. A. Scott. Describes a visit to Mr. Keely's laboratory and the experiments witnessed, with the conclusion that there was no evidence produced that a new form of force had been discovered. Ill. 10000 w. Pro Eng's Club of Phila—Jan., 1898. No. 18766 D.

Steam Consumption.

See Marine Engineering.

Valve Gears.

Valve Gear Design. Jas. Dunlop. The first of a series of articles treating of this subject designed to meet the requirements of engineers designing engines. Almost every type of engine is intended to be dealt with and the development of valve gears from their simplest to their more complicated forms illustrated. 2200 w. Prac Eng—Feb. 18, 1898. Serial. 1st part. No. 18731 A.

POWER AND TRANSMISSION.

Belts.

Belt Driving. John Tullis. Read at the West of Scotland Technical College Scientific Society. Deals with the manufacture, use, care, speed, &c., of belts, and subjects related. 2700 w. Prac Eng—March 18, 1898. Serial. 1st part. No. 19161 A.

Dynamometers.

Transmission Dynamometers. Samuel Webber. Describes various types, and the uses to which they are put, giving a simple explanation of the calculations involved. Ill. 2200 w. Mach, N. Y.—March, 1898. Serial. 1st part. No. 18878.

Elevators.

Safety Devices for Elevators. Howard Lee Davis. Illustrated description of some of the devices in use for retarding the speed and bringing the car to a standstill. 1700 w. Yale Sci M—March, 1898. No. 19013 C.

Ship Power Plants.

Central Power Plants on Board Ship vs. Distribution of Power. William S. Aldrich. Considers the advantages of having all the power required, developed in a single plant. Discusses steam, compressed air, water pressure and electricity. 3500 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18824 H.

Steel Cables.

Contract for Cables in Venezuela. Copy of a contract for the construction of steel cables between Valencia and other towns for the transport-

tation of merchandise. 700 w. Cons Repts—March 23, 1898. No. 19099 D.

Transmission.

Transmission of Power. H. R. Sutton. Deals mainly with ways to overcome and to utilize the friction between working parts. 1500 w. Prac Eng—March 18, 1898. No. 19162 A.

Water Power.

The Rational Utilization of Waterfalls of Low Head. (L'Utilisation Rationnelle des Chutes d'Eau de Faible Hauteur.) A discussion of the Von der Heydt current motor, showing the conditions of its best efficiency, and adaptation to heads of water too low for advantageous use with other motors. 3500 w. La Revue Technique—Feb. 25, 1895. No. 19204 D.

The Utilization of the Water-Power of the Rhine. C. Du Riche Preller. Considers the main features of an undertaking at Zurich for using the power of this river for lighting, industrial purposes, &c. 2000 w. Engng—March 11, 1898. No. 19059 A.

SHOP AND FOUNDRY.

Annealing.

Annealing Malleable Castings. Alexander Cairns. Read at meeting of Foundrymen's Assn., in Philadelphia. A description of the process with short discussion. 2800 w. Ir Age—March 10, 1898. No. 18898.

Brass Castings.

"Burning in" Brass Castings. C. Vickers. Directions and suggestions for "burning in" successfully. Ill. 1000 w. Mach, N. Y.—March, 1898. No. 18875.

Crane.

Electrical Crane used with the Hydraulic Riveter at the Kolomna Machine Works, Russia. (Elektrischer Kran zur Bedienung des Hydraulischen Nieters der Kolomnaer Maschinenbaufabrik.) A. Müller. A special form of bridge crane with two trolleys operated by electric motors, and used in connection with a large Tweddell hydraulic riveter. 1200 w. Zeitschr d Ver Deutscher Ing—March 5, 1898. No. 19252 D.

Foundry Practice.

The Chemistry of Foundry Practice. Ernst A. Sjöstedt. Paper to be discussed at Montreal meeting of the Federated Canadian Mining Inst. Notes and facts concerning the chemical changes taking place in the cupola. 2500 w. Can Min Rev—Feb., 1898. No. 18717 C.

Furnace Gauging.

An Instrument for Gauging the Circularity of Boiler Furnaces and Cylinders, and Producing a Diagram. T. Messenger. Read before the North-East Coast Inst. of Engs. & Shipbuilders, in South Shields. Illustrated description of apparatus for internally gauging and testing the circularity of cylinders designed particularly for use with cylindrical furnaces. 1600 w. Ind & Ir—Feb. 25, 1898. No. 18837 A.

Gears.

A Bevel-Gear Computing Machine. An illus-

trated description of instrument for the determination of the various angles required in the construction of bevel gears. The design of James Gleason. 600 w. Am Mach—March 24, 1898. No. 19096.

The Warren Bevel-Gear Generating Machine. Illustrated description of a machine for the construction of the gears of the Columbia chainless wheel. 1000 w. Am Mach—March 24, 1898. No. 19091.

Gear Teeth.

The Best Form of Curve for Gear Teeth Profiles. Replies to a letter of inquiry sent to constructors in regard to preferred practice. 2000 w. Am Mach—March 17, 1898. No. 19018.

Grinding.

Machine Grinding. C. H. Norton. The care needed in the handling of these machines. 1600 w. Am Mach—March 10, 1898. No. 18905.

Hydraulic Jointing.

Machinery for Hydraulic Jointing. Illustrated detailed description of the machinery of this system of cycle frame making as manufactured by Johnson & Phillips, of Charlton, Kent. 900 w. Engr, Lond—Feb. 18, 1898. No. 18723 A.

Japan.

The Foundries of Japan. Irvin McDowell. A letter from Yokohama, giving much information of interest. 1600 w. Ir Trd Rev—March 24, 1898. No. 19120.

Keyseating.

Devices for Keyseating Hubs, Couplings, etc. (Die Herstellung der Keilnuten in Radnaben, Wellenkupplungen, usw.) Hermann Fischer. With numerous illustrations of machines for cutting keyways in pulley hubs, &c. English and American devices principally are shown. Two articles, 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 26, 1898. No. 19248, each D.

Lathe Testing.

Testing the Accuracy of a Lathe Without Special Tools. Theodore H. Miller. Gives a very cheap and simple method, covering the points desirable to be tested. Ill. 1500 w. Am Mach—March 3, 1898. No. 18781.

Locomotive Crane.

A Five-Ton Locomotive Crane. Illustrated detailed description of a machine built by the Case Manufacturing Co., of Columbus, O., for use in mill yards, stone yards, or wherever suitable tracks are available. 1200 w. R R Gaz—March 18, 1898. No. 18998.

Lubrication.

Lubrication of Driving Journals. B. Discusses the best method of introducing oil to bearings. 1200 w. Am Eng & R R Jour—March, 1898. No. 18750 C.

Molding.

Multiple Molding. F. O. Farwell. Illustrated description of the writer's method. 1100 w. Foundry—March, 1898. No. 18939.

Molds.

A Mustard-Top Mold, and the Process of Making It. A. H. Cleaves. Illustrated detailed description. 1800 w. *Am Mach*—March 17, 1898. No. 19019.

Pig Iron.

Sandless Pig Iron. E. A. Uehling. Read before the Pittsburg Foundrymen's Assn. Showing the advantage of sandless, or machine made, pig iron, and its superiority. 4000 w. *Ir Age*—March 3, 1898. No. 18754.

Pulleys.

Pulley and Fly-Wheel Construction. Theodore F. Scheffler, Jr. Part first explains the method of calculation by an example. Tables will be given compiled from actual practice. Ill. 3000 w. *Power*—March, 1898. Serial. 1st part. No. 18879.

Riveters.

Pneumatic Percussion Riveters. An illustrated description of a machine now extensively used for bridge, boiler and structural work, for work previously done by hand. 1000 w. *Eng News*—March 3, 1898. No. 18773.

Screw Threads.

The Unification of Screw Threads Abroad. (*L'Unification des Filetages à l'Etranger.*) A report of a preliminary meeting held at Zurich to provide for an international convention for the discussion of a general unification of screw threads. 7500 w. *Bulletin de la Société d'Encour*—Feb., 1898. No. 19239 G.

Shop Costs.

An Effective System of Finding and Keeping Shop-Costs. Henry Roland. An exposition of the "job ticket" system demonstrating its simplicity and effectiveness in enabling accurate shop costs to be determined with the minimum of clerical work. 3500 w. *Engineering Magazine*—April, 1898. No. 19295 B.

Shop System.

A New Shop System. George D. Chapman. Describes the system in operation the past two years at the shops of the Fitchburg Machine Works, in Massachusetts, where tools are manufactured. Ill. 2200 w. *Mach*, N. Y.—March, 1898. No. 18876.

Swedish Machines.

A Swedish Worm Wheel Cutting Machine and a Swedish Lathe. John E. Sweet. Illustrates and describes an interesting machine for cutting accurate worm gears of any size and pitch. 900 w. *Am Mach*—March 10, 1898. No. 18902.

Tool Works.

The Niles Tool Works. History with illustrated detailed description of the present works in Cincinnati, O. 2500 w. *Ir Age*—March 24, 1898. No. 19118.

Watchmaking Tool.

Taper-Pin Turning Tool. A. H. Cleaves. Illustrates and describes a tool long in use in the watch business, for making regulator pins. 700 w. *Am Mach*—March 10, 1898. No. 18904.

MISCELLANY.**Ammunition Works.**

Kynoch's Ammunition Works. Illustrated description of the Wilton Works, near Birmingham, Eng. 2200 w. *Engng*—March 4, 1898. No. 18949 A.

Automobiles.

Boilers for Motor Cars. Editorial advocating the use of steam for the propulsion of vehicles on common roads. 1500 w. *Engr*, Lond—March 4, 1898. No. 18955 A.

Experiments Concerning Steam Road-Vehicles, and the Conclusions Drawn from Them. D. H. Simpson and W. L. Bodman. Read before the Liverpool Centre of the Self-Propelled Traffic Assn. A statement of the difficulties to be overcome, the investigations made and conclusions. 6800 w. *Ind & Ir*—Feb. 25, 1898. No. 18838 A.

The Steering of the Motor-Car: An Interesting Study. C. A. Matthey. It is proposed to study the subject in a broad way pointing out the good and bad points in existing gears and endeavoring to indicate means of securing more satisfactory results. Ill. 2000 w. *Ind & Ir*—March 18, 1898. No. 19173 A.

Ballistics.

Ballistic Problems in Indirect and Curved Fire. James M. Ingalls. Mathematical discussion, giving formulas and tables. 4500 w. *Jour of U. S. Artillery*—Jan.-Feb., 1898. No. 18938 D.

Cold.

Linde's Method of Producing Extreme Cold and Liquefying Air. J. A. Ewing. Presents a novel process made known by Dr. Carl Linde, of Munich, for attaining extremely low temperatures and for liquefying air, and calls attention to the uses to which this product may be applied. Discussion. Ill. 6800 w. *Jour Soc of Arts*—March 11, 1898. No. 19033 A.

Drying.

The Physical Principles and Practical Construction of Modern Drying Plants. (*Ueber die Physikalischen Grundlagen und die Technische Ausbildung Moderner Trockenanlagen.*) Prof. P. Pfeifer. A general discussion of the principles involved in artificial drying, and an account of the methods of construction. 4000 w. *Gesundheits Ingenieur*—Feb. 15, 1898. No. 19285 B.

Education.

Technical Education. W. E. Ayrton. Verbatim report of an address delivered to the Coventry Technical Inst., England. 3500 w. *Elec Eng*, Lond—Feb. 25, 1898. No. 18819 A.

Heat Transmission.

See Architecture and Building, Heating.

Inventions.

Rights of Employers and Employés to Inventions of the Latter. D. Walter Brown. A statement of the principles that may be considered settled relating to this subject. 900 w. *Am Mach*—March 10, 1898. No. 18903.

Kites.

Kites: Their Theory and Practice. B. F. S.

Baden-Powell. Information from the practical experience of the writer, with investigation of the theoretical principles, and discussion. Ill. 8000 w. Jour Soc of Arts—March 4, 1898. No. 18924 A.

Muscular Force.

The Influence of Frequency and Weight upon the Maximum Power of the Muscles. (De l'Influence de la Fréquence des Mouvements et du Poids Soulevé sur la Puissance Maximum du Muscle.) A paper presented to the French Academy by MM. Broca and Richet, with valuable data and diagrams of muscular effort. 1200 w. Comptes Rendus—Feb. 7, 1898. No. 19223 D.

The Influence of Intermittent Periods of Rest and Effort upon the Average Power of the Muscles. (De l'Influence des Intermittences de Repos et de Travail sur la Puissance Moyenne du Muscle.) A further contribution by MM. Broca and Richet to the French Academy upon the subject of muscular power. 1800 w. Comptes Rendus—Feb. 28, 1898. No. 19226 D.

Ordnance.

Heavy Ordnance. Osborne Atwater Day. Reviews the progress made, especially since the Civil War. 1800 w. Yale Sci M—March, 1898. No. 19015 C.

Paper Making.

The Recent History of Paper Making. Clayton Beadle. Traces briefly some of the important changes in paper making during the past hundred years. Ill. 7500 w. Jour Soc of Arts—March 18, 1898. No. 19153 A.

Pipe Coverings.

I. Experimental Determination of the Efficiency of Pipe Coverings. F. G. Gasche. Reprint from *Power* of Dec., 1896. II. The Heat-Insulating Properties of Different Steam Pipe Coverings. Tests made by F. J. Emery and J. H. Godfrey. Also other reported tests. 6500 w. N Y R R Club—Feb. 17, 1898. No. 18977 D.

Printing.

The Severy Impression Process. Melvin L. Severy. Describes a new method of printing. 4300 w. Jour Fr Inst—March, 1898. No. 18809 D.

Pump Test.

Test of Centrifugal Pump and Calibration of Weir at the Bridgeport Pumping Station, Chicago, Ill. R. C. Carpenter. Description of plant and method of testing, with results of the test of various pumps and of the calibration of the large weir. Ill. 4500 w. Sib Jour of Engng—March, 1898. No. 19081 C.

Rams.

Hydraulic Rams. J. Richards. Illustrates and describes the work of the writer in this field, showing the improvements made and yet to be desired, and giving much information of value. Also discussion. 8000 w. Jour Assn of Engng Socs—Jan., 1898. No. 18695 C.

Refrigeration.

The Theory and Practice of Mechanical Refrigeration. T. R. Murray. Read Dec. 21,

1897, before the Inst. of Engs. and Shipbuilders in Scotland. A brief description and analysis, from an engineering point of view, of the theory of the subject, and of the application of that theory to practice. 1800 w. Engr, Lond—Feb. 18, 1898. Serial. 1st part. No. 18725 A.

Rubber.

The Drying of Washed India-Rubber. A discussion of the rubber-drying process. 1600 w. Engng—Feb. 25, 1898. No. 18870 A.

Screw Fastenings.

Screw-Threaded Fastenings. G. D. Rice. Gives various forms of devices for keeping nuts and set screws from working loose. Ill. 800 w. Dom Engng—March, 1898. No. 19056 C.

Sewing Machines.

Sewing Machinery. F. W. Brady. Gives the early history, account of first patent, the principles of the chain-stitch and lock-stitch machines and other information. Ill. 2000 w. Mach, N. Y.—March, 1898. No. 18877.

Steam Pressure.

Drop of Steam Pressure in Elbows and Valves. E. C. Sickles. Gives results deduced from recent experiments, compare with the values commonly used to determine the drop in steam pressure for elbows and valves. 800 w. Sib Jour of Engng—March, 1898. No. 19082 C.

Steam Shovel.

The Thew Steam Shovel. Illustrates and describes a machine designed especially for loading iron ore from stack piles into modern high railway cars, but also useful in various kinds of work. 1100 w. Ry & Engng Rev—March 19, 1898. No. 19077.

Testing.

The International Congress for Testing Materials, held at Stockholm, 1897. (Ueber den Congress des Internationalen Verbandes für Materialprüfung in Stockholm.) Prof. F. Kick. Devoted mainly to a discussion of the work of internal friction in materials subjected to deformation, with a review of the theories of Prof. Rejto. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 18, 1898. No. 19254 B.

Time Recorder.

The Bundy Time Recorder. Illustrated detailed description of a machine for registering the actual time a workman enters and leaves the works. 1300 w. Engr, Lond.—March 11, 1898. No. 19063 A.

Vacuum.

A Hermetic Emptying Device. (Le Verseur Hermétique.) A description of the de Sennevoy device by means of which any desired amount of liquid may be drawn from a vessel without permitting the entrance of air or other substance. 1200 w. La Revue Technique—March 10, 1898. No. 19208 D.

Wire.

Wire and Wire-Making. S. Barnett. Part first gives a report of the proposed combination of all the wire interests of the United States, discussing the production and uses of this product. 2300 w. Eng & Min Jour—March 26, 1898. Serial. 1st part. No. 19125.

MINING AND METALLURGY.

COAL AND COKE.

Alaska.

Alaskan Coal Fields and Mines. An account of mines already known and the quality of the coal. Ills. & Map. 1800 w. Ir & Coal Trds Rev—Feb. 25, 1898. No. 18851 A.

Anthracite.

A Successful Experiment in Anthracite Mining. William Tate. Reports a visit to the Richards Mine of the Union Coal Co., near Mt. Carmel, Pa., giving an account of the method of obtaining 90% of the coal in pitching veins. 1800 w. Mines & Min—March, 1898. Serial. 1st part. No. 18933 c.

Early Anthracite Coal Mining in Pennsylvania. John D. Estabrook. Extracts from a paper read before the Civil Engs.' Society of St. Paul. An account of early work in Schuylkill Co., Penna. 1400 w. Ry & Engng Rev—March 26, 1898. No. 19193.

Carboniferous Deposits.

The Life Zones of the Carboniferous Deposits of Europe. Dr. Wheelton Hind, in the *Geological Magazine*. A comparison of the life zones already established in Russia and Belgium, and as far as possible contrasting the distributing of fossils with that which is found in Great Britain. 3500 w. Col Guard—March 11, 1898. No. 19066 A.

The Mineralogy of the Carboniferous. Henry S. Poole. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. Notes the presence of mineral infiltrations in addition to the regular stratified deposits of this formation. 1500 w. Can Min Rev—Feb., 1898. No. 18715 c.

China.

The Coal Fields of China. From the London *Times*. Giving information and claiming that China belongs in the front rank of coal-producing countries. 2000 w. Col Guard—March 18, 1898. No. 19180 A.

The Coalfields of Schantung. Baron von Richthofen. Brief account of the deposits of this district. 800 w. Col Guard—March 11, 1898. No. 19065 A.

Coke.

The Coke Country. H. P. Snyder. Gives the history of the coke industry, and especially of the Connellsville (Pa.) region. 3000 w. Chau—April, 1898. No. 19184 c.

Explosions.

The Chemistry of Colliery Explosions Due to Gas Derived from Coal-Dust. Donald M. D. Stuart. Read before the Phys. & Chem. Section of the Bristol (Eng.) Naturalists Society. Reviews what has been learned by investigation and observation, with conclusions. 6500 w. Col Guard—March 18, 1898. No. 19179 A.

Fan.

Farcot Fan at a Belgian Colliery. Victor Watteyne. From a report on the plant and methods of mine working at the Brussels Exhi-

bition, and also an article in *L'Industrie* of Brussels. Illustrated description. 1500 w. Col Guard—March 11, 1898. No. 19064 A.

India.

Coal Mining in India. Myles Brown. From a paper contributed to the British Soc. of Mining Students. The manner of working, appliances used, conditions of the coal trade, &c. 1800 w. Col Guard—March 4, 1898. No. 18954 A.

Umaria Colliery. Description with plan and information concerning output, earnings, &c. 1000 w. Ind Engng—Feb. 12, 1898. Serial. 1st part. No. 19028 D.

Mining Machinery.

Coal Mining by Machinery. M. E. Part first discusses the difficulties of the application of coal cutting machines in England. 1200 w. Prac Eng—March 11, 1898. Serial. 1st part. No. 19076 A.

Origin.

The Origin of Coal. E. Bertrand. Abstract of a lecture delivered in France, dealing with this subject. 1400 w. Col Guard—March 18, 1898. No. 19174 A.

Pennsylvania.

Pennsylvania Coal Statistics for 1897. Authentic and reliable data, given in tabulated form. 1000 w. Mines & Min—March, 1898. No. 18936 c.

Semi-Bituminous.

The Heating Value of Semi-Bituminous Coals. Editorial discussing the possible errors which is apt to cause the apparent heating value of the coal to be less than the true value, and so make the reported "efficiency" of a steam boiler erroneous. 1600 w. Eng News—March 24, 1898. No. 19086.

Under-Clays.

The Manufacture of Fireclay Goods from the Under-clays of Thin Coal Seams. Philip Kirkup. Read at meeting of Fed. Inst. of Min. Engs., at Newcastle-on-Tyne. Presents the importance of utilizing any by-product possible, to assist in the profitable working of a colliery, especially in the working of thin seams, and gives general description of articles made from fireclay. 3500 w. Col Guard—March 5, 1898. No. 18853 A.

Wallsend Colliery.

Historical Notes on Wallsend Colliery, England. T. E. Forster. The Re-opening of Wallsend Colliery. Henry Ayton. Two papers read at meeting of Fed. Inst. of Min. Engs., at Newcastle on-Tyne, concerning an interesting and valuable colliery. 3800 w. Col Guard—Feb. 25, 1898. No. 18854 A.

Washing.

Coal Washing. William B. Phillips. From advance sheets of second edition of "Iron Making in Alabama." Reviews the history of the industry in this state and gives information of changes effected by washing, and results ob-

tained. 3300 w. Am Mfr & Ir Wld—March 25, 1898. No. 19137.

COPPER.

Colorado.

Colorado's Copper Output. A report of the yield of mines of the Paradox Valley, in the La Sal Mountains. 2000 w. Min Ind & Rev—March 10, 1898. No. 18975.

Mexico.

A New Copper Deposit in Mexico. Ernest du B. Lukis. A report of the mine known as La Aurora, in the State of Puebla, Mexico. 1200 w. Eng & Min Jour—March 5, 1898. No. 18848.

Mining Points of Interest in Mexico. A. F. Wuench. Gives an account of the Velardena district, the state of Jalisco, and of a copper and molybdenum mine. 2300 w. Min Ind & Rev—March 10, 1898. No. 18973.

New Mexico.

Copper Deposits of Mora County, New Mexico. W. L. Austin. Abstract of a paper read before the Colorado Scientific Soc., in Denver. Describes these deposits and gives the writer's explanation of their probable origin. Not of commercial value. 900 w. Eng & Min Jour—March 26, 1898. No. 19124.

GOLD AND SILVER.

Alaska.

Alaska and Its Mineral Resources. Arthur Lakes. Abstract from the *Alaska Mining Record*. The geographical situation of the mining districts with account of their discovery, the development work, and the conditions under which the work must be done. 2500 w. Mines & Min—March, 1898. No. 18934 c.

Gold Deposits, Geology and Geography of Alaska. Information from a U. S. Government pamphlet prepared by W. H. Dall and F. C. Schrader, and edited by S. F. Emmons. 4500 w. Min & Sci Pr—March 19, 1898. Serial. 1st part. No. 19122.

Gold Fields of Alaska: Rush of Prospectors. Reports the large number of prospectors already on the Pacific coast en route for these gold fields, and comments on the movements of Canada aiming to securing as large benefits as possible from the discovery. 800 w. Cons Repts—March 11, 1898. No. 18922.

The Yukon Mining Region. Charles G. Yale. The conditions at present existing, the high price of living and transportation, the severity of the climate, and the expectations are discussed. 2300 w. Min Ind & Rev—March 10, 1898. No. 18974.

Australia.

Northern Goldfields, W. A. S. J. Becher. Part first describes the fields of Pilbarra and West Pilbarra. Ill. 1100 w. Aust Min Stand—Jan. 20, 1898. Serial. 1st part. No. 18961 B.

Notes on the Geology and Mineral Deposits of West Australia. E. F. Pittman. Read before the Australasian Assn. for the Advancement of Science. Descriptive. 6500 w. Aust Min Stand—Jan. 27 & Feb. 10, 1898. Two parts. No. 18987 E.

Cyanid Process.

Chemistry of the Cyanid Process. Reviews the theories which have been formulated to explain how gold becomes dissolved in this process. 2200 w. Min & Sci Pr—March 12, 1898. No. 19011.

The Stamp Milling of Gold Ores in its Relation to Cyaniding. Discussion of paper by E. H. Johnson. 4400 w. Chem & Met Soc of S. Africa—Jan. 29, 1898. No. 18929 D.

Fusion.

The Melting Points of Silver and Gold. (Sur les Points de Fusion de l'Argent et de l'Or.) New determinations by M. Berthelot, together with comparisons of his results with those of other authorities since 1863. The results are 962° C. for silver, and 1064° C. for gold. 1500 w. Comptes Rendus—Feb. 7, 1898. No. 19222 D.

Hungary.

The Gold-Silver Mines in Kapnik, Hungary. R. Helmhacker. Describes the deposit, and the extraction process in use. 4200 w. Min & Sci Pr—March 12, 1898. No. 19010.

Klondike.

The River Trip to the Klondike. John Sidney Webb. Interesting account of the country and life of the miners, with some information of method of mining, &c. Ill. 12000 w. Century Mag—March, 1898. No. 18743 D.

The Rush to the Klondike over the Mountain Passes. Edward S. Curtis. Brief account of the difficulties encountered on this route in 1897. Ill. 1400 w. Century Mag—March, 1898. No. 18744 D.

The Rush to the Klondike. Sam Stone Bush. An article on the present output and future promise of Alaska's new gold fields, by an observer. Gives characteristics of the country, methods of mining and living, &c. Ill. 12000 w. Am Rev of Revs—March, 1898. No. 18785 c.

Ore Bodies.

Rosita and Silver Cliff. Arthur Lakes. The peculiar forms of the ore formation found in the necks of old volcanoes in Colorado; what they are composed of and the means by which they were deposited. Ill. 3300 w. Mines & Min—March, 1898. No. 18935 c.

River Mining.

River Mining in California. R. L. Dunn. Considers the appliances for working, and the subject generally. 4800 w. Min & Sci Pr—March 19, 1898. No. 19121.

Sierra Nevada.

The Primary Gold Deposits of the Sierra Nevada. Waldemar Lindgren. Information of the age, occurrence, character and forms of the deposit, with conclusions relating to their origin. 3300 w. Engng Jour—Feb., 1898. No. 18913 c.

Smelting.

Recent Smelting Practice in Colorado. L. S. Austin. Improvements in the practice of smelting, confined to the so-called lead and copper

smelters, where these metals are used for collectors of gold and silver in the ores. 3000 w. Eng & Min Jour—March 5, 1898. No. 18849.

The Possibilities of Smelting in B. C. R. A. Hedley. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. The opinions of the writer, based on a knowledge of the country and a study of its ores. 1500 w. Can Min Rev—Feb., 1898. No. 18714 C.

Tailings.

The Treatment of Tailings by the Direct-Filling Process. F. Cardell Pengilly. Abstract of a paper read before the Inst. of Min. and Met., London. Describes this method as used successfully at mines on the Witwatersrand. 1000 w. Eng & Min Jour—March 19, 1898. No. 19041.

Transvaal.

Auriferous Conglomerate of the Transvaal. George F. Becker. A consideration of the nature of this wonderful deposit, and the theories advanced to account for the deposition. 7800 w. Am Jour of Sci—March, 1898. No. 18761 D.

Witwatersrand.

Mining the Gold Ores of the Witwatersrand. H. H. Webb, Pope Yeatman. A general account of the methods employed in dealing with the mining problems of this field, with many illustrations of the plant at the leading mines, and a description of the machinery used. 4000 w. Engineering Magazine—April, 1898. No. 19292 B.

IRON AND STEEL.

Blast Furnaces.

Destruction of Blast-Furnace Lining by Carbon. F. W. Luermann. Translated from *Stahl und Eisen*. Considers it due to iron pyrites in the fire clay, and the furnace gases entering the brick. 1200 w. Am Mfr & Ir Wld—March 11, 1898. No. 18988.

Blowing Engines.

See Mechanical Engineering, Power.

Hard Steel.

The Use of Steel. Editorial concerning the increasing use of harder and harder varieties of steel. 1200 w. Engng—March 4, 1898. No. 18950 A.

Iron Ore.

The Deposits of Oolitic Iron Ore in the New Basin of Briey. (Les Gisements de Minerais de Fer Oolithiques du Nouveau Bassin de Briey, Meurthe-et-Moselle.) G. Rolland. An account of the development of these new sources of iron ore in the north-eastern part of France. 1500 w. Moniteur Industrielle—Feb. 12, 1898. No. 19240 G.

Nickel Steel.

Investigations upon Nickel Steel. (Recherches sur les Aciers au Nickel.) A paper by M. Guillaume discussing the behavior of various alloys at different temperatures. 1000 w. Comptes Rendus—March 7, 1898. No. 19228 D.

Nickel Steel for Crank Pins and Axles. H. F. J. Porter. Condensed. Gives results of tests, and shows that this metal possesses valuable qualities, and insures a combination of elastic strength and ductility. 2000 w. Am Mach—March 24, 1898. No. 19093.

Ore Washers.

Removal of Sand from Waste Water of Ore Washers. J. E. Johnson, Jr. Abstract of a paper read before the Am. Inst. of Min. Eng., at the Atlantic City meeting. Illustrates and describes the machine used at the plant of the Longdale Iron Co., in Virginia. 1200 w. Eng & Min Jour—March 12, 1898. No. 18930.

Pig Iron.

See Mechanical Engineering, Shop & Foundry.

Rolling Mills.

Modern Rolling Mills. John S. Hunting. Read before the West of Scotland Iron and Steel Inst. Mentions different types of mills, discusses methods, and suggests considerations necessary in the construction and working of steel mills. 2500 w. Col Guard—March 18, 1898. No. 19178 A.

Steel.

Acid vs. Basic Steel. The views of two leading manufacturers as to the reliability of the two processes. 1300 w. Ir Age—March 10, 1898. No. 18897.

Thin Sheets.

To Distinguish Iron from Steel When in Thin Sheets. Gus C. Henning. Ten tests are given, in response to an inquiry. 1600 w. Am Mach—March 24, 1898. No. 19092.

Toughening.

The Coffin Toughening Process. L. R. Pomeroy. From a paper presented at the Feb. meeting of the Western Railway Club. This process of toughening steel is described, its advantages discussed, and tests reported. 1600 w. R R Gaz—March 18, 1898. No. 18999.

MINING.

Canadian Mining.

Mr. Hamilton Smith on Canadian Mining Regulations. Extracts from a letter published in the Montreal *Star* containing much of interest in regard to the mining regulations for the Yukon district. 1200 w. Eng & Min Jour—March 19, 1898. No. 19040.

Deep Pits.

The Installation of Very Deep Pits. (Installation des Puits à Grande Profondeur.) E. Thomson. Devoted to the equipment of deep pits, including the winding machinery, headworks, cages, rails, &c.; especially in respect to the practice of the Dortmund district. 1500 w. 3 plates. Revue Universelle des Mines—Feb., 1898. No. 19262 H.

Explosives.

Improvements in Safety Explosives. E. M. Hann. Read before the South Wales Inst. of Engineers. Deals with experiments carried out during the last three years, describing the apparatus used. 1500 w. Col Guard—March 18, 1898. No. 19177 A.

The Manufacture of Nitro-Explosives. August Prister. Discusses the manufacture of nitro-glycerine, and different kinds of dynamite. 5600 w. Chem & Met Soc of S Africa—Jan. 15, 1898. No. 18807 D.

Firedamp.

Explosives and Firedamp in Austria. (Les Explosifs et le Grisou en Autriche.) A review of the work of the Austrian government Commission upon the action of mining explosives in igniting firedamp. Two articles. 4500 w. Le Génie Civil—March 5, 12, 1898. No. 19218 each D

Researches upon the Explosion of Gaseous Mixtures by Electric Currents. (Recherches sur l'Explosion des Mélanges Grisouteux par les Courants Electriques.) Paper by MM. Couriot and Meunier relating the results of experiments to determine the igniting effect of incandescent wires and electric sparks upon mixtures of air and firedamp. 1200 w. Comptes Rendus—March 7, 1898. No. 19230 D.

Miners' Outfits.

Canadian Duties on Miners' Outfits. A copy of the instructions issued to customs officers. 900 w. Cons Repts—March 24, 1898. No. 19101 D.

Mining Labor.

See Economics and Industry, Labor.

Mining Law.

Appointment of Receiver and Manager of Mines. British law as applied to this subject, illustrated by special cases. 1800 w. Col Guard—March 4, 1898. No. 18952 A.

New Canadian Mining Regulations. A copy of the new regulations issued by the Interior Department of Canada, governing mining in the Yukon regions. 5500 w. Cons Repts—March 10, 1898. No. 18906 D.

The Law as to Dredging in Rivers for Gold. R. W. Raymond. Some information on points bearing upon this subject. 900 w. Eng & Min Jour—March 5, 1898. No. 18847.

Mining Machinery.

An Interesting Electric Mining Plant. Illustrated description of plant near Wilkesbarre, Pa. 1200 w. Elec Rev, N. Y.—March 6, 1898. No. 18990.

Electricity in Mining Operations. F. A. C. Perrine. A review of the present applications in this field and of the improvements needed. 2000 w. Engng Jour—Feb., 1898. No. 18914 C.

Some Considerations Affecting the Design of Mining Motors. F. C. Caldwell. Read before the Ohio Inst. of Mining Engs. Calls attention to some points to be borne in mind in deciding on the claims to excellence of any machine. 2300 w. Am Mfr & Ir Wld—March 25, 1898. No. 19136.

Some Modern Forms of Mining Machinery. Frederick T. Snyder. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. Describes machinery designed to meet specific conditions of the gold ores of the Lake of the Woods, many of which are low in grade, but contain streaks of high values. Ill. 3000 w. Can Min Rev—Feb., 1898. No. 18713 C.

Shafts.

Notes on Shaft Sinking. W. Teague. Read before the Inst. of Min. & Met., England. Favors round shafts and states their advantages; briefly considers ventilation, size, and inclined shafts. 1200 w. Col Guard—Feb. 25, 1898. No. 18856 A.

Training.

Technical Training in Mining. Henry Louis. Read at meeting of Federated Inst. of Min. Engs., at Newcastle-on-Tyne. An examination of the principles that should form the basis of a sound mining education. Discussion. 4700 w. Col Guard—Feb. 25, 1898. No. 18852 A.

Ventilation.

Mine Atmosphere. From the *Cours d'Exploitation des Mines*, by M. Haton de la Goupillière. Considers both the temperature and chemical composition, the regulation of the air supply, and effect on the workers. 4700 w. Col Guard—Feb. 25, 1898. No. 18855 A.

Water Motors.

Small Water Motors for Mines. George D. Rice. Shows several forms of simple motors, with details of making. Ill. 800 w. Eng & Min Jour—March 5, 1898. No. 18850.

MISCELLANY.

Aluminum.

Notes on Aluminum. Jesse M. Smith. Much information of this metal, its properties, uses, cost, &c. with discussion. 11000 w. Jour Assn of Engng Soc—Jan., 1898. No. 18694 C.

Bessemer.

A Metallurgical Revolutionist. Brief review of the life and many inventions of Sir Henry Bessemer. 1500 w. Transport—March 18, 1898. No. 19160 A.

Sir Henry Bessemer. Sketch of his life and work. 2200 w. Engr, Lond—March 18, 1898. No. 19164 A.

The Late Sir Henry Bessemer. An account of the interesting career of this well-known metallurgist, with portrait. Ill. 6000 w. Ir. & Coal Trds Rev—March 18, 1898. No. 19181 A.

The Late Sir Henry Bessemer. Biographical sketch with some of the episodes of his career. 3500 w. Engng—March 18, 1898. No. 19170 A.

British Columbia.

The Mineral Act of British Columbia. R. W. Raymond. Considers various points of the law, especially the size of claims, the proof of their mineral value, and the manner of their demarkation. 2000 w. Can Min Rev—Feb., 1898. No. 18712 C.

Coal Ash.

Fusibility of Coal Ash Determined by Its Composition. Eugène Prost. Showing that the fusibility of an ash depends upon the relation between the flux and the silica and alumina. 800 w. Col Guard—March 18, 1898. No. 19175 A.

Exposition.

Notes on the Exposition of 1900. (A Propos de l'Exposition de 1900.) Giving some account

of the progress in coal mining during the century, as it will be shown at the coming exposition. 2000 w. *La Revue Technique*—Feb. 10, 1898. No. 19202 D.

Glass Works.

The Glass Works of Val Saint-Lambert. (Les Cristalleries du Val Saint-Lambert.) A general descriptive account of the great glass works of Belgium, where 4500 employés are engaged in the production of the finest cut-glass ware. 3000 w. *La Revue Technique*—Feb. 25, 1898. No. 19203 D.

Helena, Mont.

The Geology of Helena, Montana, and Vicinity. L. S. Griswold. A detailed account of the geology of this city and its relation to the region roundabout, with conclusions. 7000 w. *Jour Assn of Engng Socs*—Jan., 1898. No. 18696 c.

Manganese.

Manganese Mining in New Brunswick. Describes the deposits of bog manganese, and the method of treatment necessary to make it useful for commercial purposes. 1800 w. *Cons Repts*—March 24, 1898. No. 19102 D.

Manjak.

Occurrence and Mining of Manjak in Barbadoes, West Indies. Walter Merivale. Read at meeting of the North of England Inst. of Min. & Mech. Engs., at Newcastle-upon-Tyne. Abstract. Manjak is one of the bitumens. Its manner of deposit is described. 1000 w. *Ir & Coal Trds Rev*—Feb. 18, 1898. No. 18728 A.

Miners' Food.

Some Concentrated Foods for Miners, Prospectors and Explorers. J. T. Donald. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. Presents information concerning concentrated foods which have been used by explorers with satisfactory results. 1500 w. *Can Min Rev*—Feb., 1898. No. 18716 c.

Petroleum.

How to Utilize the Waste Products of Petroleum Refineries. R. Zaloziecki. Calls attention to the money loss from failing to utilize this waste, also the harm from allowing it to poison water-courses. Gives various methods employed in different places. 2000 w. *Am Mfr & Ir Wld*—Feb. 25, 1898. No. 18706.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene (Acétylène). Illustrated description of the improved acetylene generator of the *Société Internationale de l'Acétylène*, with data as to the advantages of this illuminant, both for train lighting and stationary service. 1500 w. *La Revue Technique*—Feb. 25, 1898. No. 19206 D.

Acetylene. W. H. Tozer. Describes the gas and its production from calcic carbid, and considers its prospects. 2000 w. *Prac Eng*—March 4, 1898. No. 18983 A.

Acetylene Gas: Its Generation and Use. Thomas Glover. Read before the Midland Assn. of Gas Managers. Refers to the manufacture, makes a comparison of cost as a supply for light and heat, describes generating apparatus, &c. 1800 w. *Gas Wld*—Feb. 26, 1898. No. 18841 A.

Acetylene Gas, the New Illuminant. C. T. Marshall. Read at meeting of the Northern Arch. Assn., Newcastle, Eng. Brief history of the gas and its generation. 2400 w. *Arch, Lond*—March 11, 1898. No. 19074 A.

Acetylene Lighting at Vienna. From *Journal für Gasbeleuchtung*. Describes the arrangement for lighting the Franzenplatzes both by illuminating gas and acetylene. Ill. 700 w. *Pro Age*—March 15, 1898. No. 18993.

Acetylene Regulations for New York. Requirements of the N. Y. Board of Fire Underwriters for the installation of acetylene gas generators and for the storage of a limited supply of calcium carbid. 900 w. *Pro Age*—March 1, 1898. No. 18779.

Burners for Acetylene. Abstract translation

of articles by Dr. Paul Wolff, published in the *Zeitschrift für Beleuchtungswesen*, giving tests of various burners, and some information on the illuminating value of this gas. 2000 w. *Jour of Gas Lgt*—March 1, 1898. No. 18964 A.

Address.

Inaugural Address before the Manchester District Institution of Gas Managers. W. S. Haddock. Considers many matters connected with the gas industry. 4000 w. *Jour Gas Lgt*—March 1, 1898. No. 18963 A.

Inaugural Address of J. T. Lewis before the Midland Assn. of Gas Managers, in Birmingham, Eng. Considers the labor problem, progress made in the carbonizing of coal for gas, coal handling in the retort house, &c. 8500 w. *Gas Wld*—Feb. 26, 1898. No. 18840 A.

Alignment.

Effect of Deflection in Alignment on the Flow of Gas in Street Mains. G. A. Hyde. Read before the Ohio Gas Lgt Assn. Shows that right-angle deflections are objectionable and should be avoided. Ill. 800 w. *Am Gas Lgt Jour*—March 28, 1898. No. 19142.

Ammonia.

Sulphate of Ammonia in Farming. John Hunter. Presents the merits of sulphate of ammonia in agriculture, as based on results obtained on the Dalmeny farms of Lord Rosebery. 2200 w. *Gas Wld*—March 12, 1898. No. 19070 A.

Burners.

Some Incandescent Burners. N. W. Gifford. Read at meeting of New Eng. Assn. of Gas Engs. An account of tests made by the writer. Discussion. 7400 w. *Am Gas Lgt Jour*—March 7, 1898. No. 18862.

Competition.

How to Avoid Competition in a Small Town. E. G. Schmidt. Read before the Ohio Gas Light Assn. Gives the experiences of the Sandusky (O.) Gas Lgt Co. and recommends the combining of the electric light and gas interests. 2500 w. Am Gas Lgt Jour—March 28, 1898. No. 19138.

Distribution.

The Distribution of Gas. D. Coats Niven. A reply to criticisms by Messrs. Skinner and Canning on a previous article of the writer. 2200 w. Jour of Gas Lgt—March 15, 1898. No. 19126 A.

Dry Mains.

An Experience with Dry Mains. H. Kendrick. Read at meeting of Manchester Dist. Inst. of Gas Engrs. (England). Describes the plant at Stretford, the stoppages, the system in use, with its advantages and disadvantages. Also discussion. 4700 w. Gas Wld—March 5, 1898. No. 18956 A.

European Gas.

Some Notes on European Gas Matters. Walter S. Allen. Read before the New England Assn. of Gas Engrs. Impressions received during a visit to Europe, noting matters of interest at various points. Discussion. 8500 w. Am Gas Lgt Jour—March 7, 1898. No. 18861.

Gasholders.

A Curious Old Gasholder. Describes an old American gasholder. Ill. 700 w. Am Gas Lgt Jour—Feb. 28, 1898. No. 18710.

Gasholder Construction. H. A. Allyn. Read before the New England Assn. of Gas Engrs. Considers the determining of capacity, whether the holder shall be covered, materials to be used, and other details. Discussion. 9500 w. Am Gas Lgt Jour—Feb. 28, 1898. No. 18709.

Illumination.

Diffused Illumination. William Hallock. Some points on illumination in general, with consideration of the application of diffused illumination in the lighting of Columbia University Library. Ill. 1300 w. Pro Age—March 1, 1898. No. 18778.

Incandescent Lamp.

Lighting with Acetylene and Spirit Incandescent Lamps. (Ueber Acetylen-und Spiritus-Glühlicht-Beleuchtung.) A paper by Herr Gerdes, before the society of mechanical engineers, comparing acetylene with the light from alcohol incandescent lamps; with discussion. 3000 w. Glaser's Annalen—Feb. 15, 1898. No. 19278 D.

Incandescents.

The War of the Incandescents: Gas Versus Electric. J. H. Maxon. Read before the Ohio Gas Lgt. Assn. Suggests the means and presents the importance of pushing the sale of the best incandescent gas burners. 2000 w. Am Gas Lgt Jour—March 28, 1898. No. 19139.

London Gas.

London Gas: Its Supply and Quality. An account of the manner in which the gas supplied is tested to ascertain its lighting power,

purity, and pressure. 2200 w. Builder—March 5, 1898. No. 18958 A.

Municipal Lighting.

See Electrical Engineering, Lighting.

Purifying.

A Closed Purifying Vessel. Henry G. Beatley. Read at meeting of the Mich. Gas Assn., at Port Huron, Mich. Presents the apparatus and discusses some of the advantages to be derived from its use. Ill. 3000 w. Pro Age—March 1, 1898. No. 18777.

Still Another Purifying Box. Irvin Butterworth. Read before the Ohio Gas Lgt. Assn. Illustrated description of the Doherty-Butterworth, or "Simplex" box, with a statement of some of the advantages. 3000 w. Am Gas Lgt Jour—March 28, 1898. No. 19140.

Regulating.

Regulating the Addition of Air to Gas. Herr Irminger. Shows how the amount may be easily regulated by means of a small rotary exhauster. 800 w. Jour of Gas Lgt—March 15, 1898. No. 19127 A.

Retorts.

The Construction of Inclined Gas-Retorts, Charging Apparatus, and Conveying Machinery. Maurice Graham. Read before the Birmingham (Eng.) Assn. of Mech. Engrs. Discusses the most efficacious means for the transmission of coal and its carbonization in gas-works. Ill. 5500 w. Jour of Gas Lgt—March 15, 1898. Serial. 1st part. No. 19129 A.

Revivifier.

Comparative Results With or Without the Use of a Continuous Oxid Revivifier. Moses Coombs. Read before the Ohio Gas Lgt. Assn. Gives a statement of results showing the improvement obtained by the use of a continuous oxid revivifier. Ill. 1200 w. Am Gas Lgt Jour—March 28, 1898. No. 19141.

Spent Oxid.

The Valuation of Spent Oxid. Dr. Lubberger, in *Journal für Gasbeleuchtung*. Showing that it is often valued solely on the basis of the amount of prussian blue which it contains, and the methods of estimating, with other particulars. 1100 w. Jour of Gas Lgt—March 15, 1898. No. 19128 A.

Tar.

The Utilization of Coal Tar by Distillation. Edward J. Elles. Read at meeting of Mich. Gas Assn. at Port Huron, Mich. Data relating to the production of pitch, light and heavy oils and ammoniacal liquor obtained from actual results by the distillation of coal tar from the plant of the Detroit Gas Co. Ill. 3200 w. Pro Age—March 1, 1898. No. 18776.

Welsbach.

Experiments with the Welsbach Lamp. F. H. Hess. Read at meeting of the Mich. Gas Assn. at Port Huron, Mich. Considers the fundamental principles upon which a perfectly burning lamp depend, and points out some of the errors to be avoided in the manipulation of a Welsbach lamp. 3800 w. Pro Age—March 1, 1898. No. 18775.

SEWERAGE.

Liernur System.

The Liernur System in Amsterdam. (Das Liernur System in Amsterdam.) An illustrated account of the working of the Liernur pneumatic sewerage system in Amsterdam, where it has been in successful operation since 1870. 1000 w. Glaser's Annalen—March 1, 1898. No. 19281 D.

Pipe Sewers.

Flushing in Pipe Sewers. H. N. Ogden. Considers the subject carefully and the hydraulic problem involved, giving much needed information on the use of flush-tanks. 4400 w. Pro of Am Soc of Civ Engs—March, 1898. No. 19109 F.

Purification.

Sewage Purification by Intermittent Filtration at Spencer, Mass. Information of this plant with details of the sewage-screening chamber. 1500 w. Eng News—March 24, 1898. No. 19085.

Seine.

The Sanitation of the Seine. (L'Assainissement de la Seine.) G. Bechmann. A very full review of the sewage works nearly completed; which take all the sewerage of Paris, formerly discharged into the Seine, and deliver it to the sewage farms of Achères. Details of the important aqueduct and siphon work are given. A valuable paper. 7500 w. Bulletin de la Société d'Encour—Feb., 1898. No. 19238 G.

Sewage Farm.

The Sewage Farm of Achères, Paris. An article prepared from data contained in a very full description by the engineers in charge, published in the "Annales des Ponts et Chaussées." 3500 w. Eng News—March 17, 1898. No. 19022.

STREETS AND PAVEMENTS.

Brick Paving.

Paving Bricks. T. C. Hopkins. Gives brief history of the use of bricks for this purpose, the materials and essential properties, the testing, and a comparison with other materials. 2000 w. Engng Jour—Feb., 1898. No. 81915 C.

WATER SUPPLY.

Air Leaks.

Handling Air in a Tube Well Pumping Plant. D. N. Tower. A brief description of the Cohasset water works, near Boston, and the writer's experience in fighting air leaks in the wells and suction mains of a driven well supply. 2400 w. Jour of N Eng Water Works Assn—March, 1898. No. 18817 F.

Artesian Supply.

Artesian Water Supply of Galveston, Tex. R. H. Peek. Describes a system consisting of 30 artesian wells, 27 being 7 ins. and three being 9 ins. in diameter, connected by an influent pipe directly with the 30-in. conduit to the receiving tank. Ill. 1900 w. Eng News—March 3, 1898. No. 18768.

Checking Waste.

The Water Supply Problem in Washington, D. C. Explains methods of utilizing present supply to better advantage by checking waste. 1800 w. Eng Rec—March 12, 1898. No. 18925.

Cleaning Mains.

Water Main Cleaning in St. John, N. B. Describes the mechanical scraper used and the method of cleaning. 1800 w. Can Eng—March, 1898. No. 18985.

Dam.

A Rock-Fill Dam with a Steel Heartwall at Otay, Cal. One of the three reservoirs for the water-supply of San Diego. The construction is illustrated and described. 3700 w. Eng News—March 10, 1898. No. 18909.

See also Civil Engineering, Irrigation.

Domestic Supply.

Purification of Domestic Water Supply. Homer T. Varyan. The writer proposes to heat every drop of water to 230° F. for seven minutes before it enters the mains. 14000 w. Engr, N. Y.—March 1, 1898. No. 18780.

Filling.

Back Filling Trenches. E. A. W. Hammatt. Calls attention to points from the experience of the writer, and discusses the manner of back filling to be recommended. Discussion follows. 6000 w. Jour of N Eng Water Works Assn—March, 1898. No. 18815 F.

Back Filling Trenches. E. H. Gowing. Considers the expense of doing the work as it should be done. Also discussion. 6400 w. Jour of the N Eng Water Works Assn—March, 1898. No. 18816 F.

Filtration.

A Russian View of Mechanical Filtration. Nicholas P. Simin. Gives recommendations for improvements which have been hinted many times by engineers, although never before printed. 800 w. Eng Rec—March 19, 1898. No. 19038.

Flow.

The Flow of Water in Pipes. E. Sherman Gould. Considers only pipes of 1000 diameters and upward in length. 1800 w. Am Mach—March 3, 1898. No. 18784.

High-Pressure System.

The Separate High-Pressure Fire Service System at Providence, R. I. Information of this recently completed work, the area covered, length of pipe, pressure, cost, &c. Ill. 1100 w. Eng News—March 24, 1898. No. 19089.

Jersey City, N. J.

Jersey City's Water Supply. An editorial explanation of the manner in which this city's water supply is gradually passing into the control of private companies. 2500 w. Eng Rec—March 19, 1898. No. 19034.

Kingston, N. Y.

The Kingston, N. Y., Water-Works. Describes a 40,000,000 gallon reservoir and mechanical filter plant. Ill. 2000 w. Eng Rec—March 19, 1898. No. 19037.

Newport, N. H.

Construction of the Newport, N. H., Water Works. Lucian A. Taylor. Describes the works. Discussion. 3500 w. Jour of N Eng Water Works Assn—March, 1898. No. 18813 F.

Philadelphia.

The Water Supply Crisis at Philadelphia. Editorial on the plan of turning over the water-supply to a private corporation, setting forth the facts and commenting unfavorably. 2400w. Eng News—March 3, 1898. No. 18772.

Pumping Engine.

Test of the Triple Expansion Pumping Engine at the St. Gall Waterworks. (Versuche an einer Dreistufigen Dampf-Pumpmaschine im Wasserwerke der Stadt St. Gallen.) A full account of the tests made by Prof. Stodola of this fine Sulzer pumping engine; a steam consumption as low as 11.2 pounds per h. p. hour was attained. Three articles. 10000 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 26, March 5, 1898. No. 19247 each D.

Reservoirs.

Reservoir Embankments, with Suggestions for Avoiding and Remedying Failures. William Fox. Read before the Soc. of Engs., London. General remarks followed by description of difficulties and means adopted to overcome them. The subject is confined to embankments constructed across natural valleys. Ill. 5000 w. Ind & Ir—March 11, 1898. No. 19042 A.

The Worcester Distributing Reservoir. Walter E. Hassam. Brief description of work undertaken with view to the future supply of water to the fast-growing city of Worcester, Mass. Ill. 1800 w. Jour of N Eng Water Works Assn—March, 1898. No. 18814 F.

River Crossing.

Placing a 10-Inch High-Service Pipe Across a River. Frederick W. Gow. Describes the method of crossing the Mystic river, at Medford, Mass. Discussion. 4000 w. Jour of N Eng Water Works Assn—March, 1898. No. 18818 F.

San Francisco, Cal.

Water Supply of San Francisco. Brief account of this works and history of the supply since 1855. 1200 w. Fire & Water—March 12, 1898. No. 18937.

San Jose, Cal.

Water Supply of San Jose, Cal. Henry A. Brainard. Brief description of the system, whose principal source of supply is found in mountain streams fed by strong springs. 1000 w. Fire & Water—March 26, 1898. No. 19134.

Savannah, Ga.

The Restoration of the Water Supply at Savannah, Georgia. Thomas T. Johnson. An account of steps taken to restore what appeared to be a decaying artesian water supply. Ill. 6000 w. Jour of W Soc of Engs—Dec., 1897. No. 18805 D.

Standpipe.

Erection of the Flushing Standpipe. Illustrates a floating stage inside the tank and raised

by pumping water into the space below it as the work progresses. 1800 w. Eng Rec—March 26, 1898. No. 19131.

Steubenville, O.

Water System of Steubenville, Ohio. Part first gives a brief historical review of the water-works systems dating back to 1810, with illustrations. 900 w. Fire & Water—March 5, 1898. Serial. 1st part. No. 18820.

Syracuse Rules.

Rules of Syracuse (N. Y.) Water Department. A copy of the rules and regulations which must be signed by all water takers. 2000 w. Fire & Water—March 26, 1898. Serial. 1st part. No. 19135.

Town Supplies.

Springs and Wells for Town Supplies. H. W. Pearson. Extracts from paper read at meeting of British Assn. of Water Works Engineers, with résumé of discussion. 5000 w. Jour Gas Lgt—Feb 22, 1898. No. 18757 A.

Valparaiso.

Works for the Supply of Potable Water to Valparaiso, Chili. (Travaux d'Adduction d'Eau Potable à Valparaiso, Chili.) A. Marquand. Describing the dam, reservoir and aqueduct recently completed. A supply of over 22,000,000 gallons per day is rendered available by gravity from Penuelas, 12 miles distant. 3500 w. 1 plate. Le Génie Civil—March 12, 1898. No. 19220 D.

Water Analysis.

The Interpretation of Sanitary Water Analyses. Floyd Davis. A discussion of the questions which must be considered in drawing conclusions from sanitary water analyses, both chemical and microscopical, both with regard to the evidences of safety and the detection of pollution. 3500 w. Engineering Magazine—April, 1898. No. 19294 B.

Water Question.

The Water Question in the Borough of Queens, New York. Reviews the water supplies of the various plants within this territory, discussing their condition and how to supply abundance of potable water when needed. 2200 w. Fire & Water—March 19, 1898. No. 19057.

MISCELLANY.**Dust Van.**

Motor Dust-Vans. T. W. E. Higgens' report to the vestry of the parish of Chelsea, on the purchase of motor dust-vans. 3000 w. Elec Eng, Lond—March 18, 1898. No. 19157 A.

Garbage.

A Test of a Refuse Crematory. Describes a test of a plant at Leyton, England, which burns about 1700 tons of refuse and sewage sludge annually, the heated gases being used under two 96 h. p. boilers. 800 w. Eng Rec—March 5, 1898. No. 18891.

The Use of Garbage as Fuel. Explanation of conditions of hygienic cremation of garbage which render the process of doubtful utility in connection with commercially operated boilers. 9000 w. Eng Rec—March 5, 1898. No. 18887.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Notes on Railway Accidents. (A Propos des Accidents de Chemins de Fer.) Léo Dex. A classification of accidents by their causes, and a critical discussion of the best means of prevention. 1800 w. La Revue Technique—Feb. 10, 1898. No. 19201 D.

Train Accidents in the United States in January. Detailed list and classified summary. 4500 w. R R Gaz—March 11, 1898. No. 18941.

Train Accidents in the United States in February. Detailed list and classified summary, with remarks. 3000 w. R R Gaz—March 25, 1898. No. 19116.

American Railways.

An English View of Our Railways. W. M. Acworth. Gives impressions of a recent visit. 3300 w. Ry Age—Feb. 25, 1898. No. 18708.

FINANCIAL.

Car Accounts.

Car Accounts Without Books. Illustrates and describes the system of car accounting, invented by W. E. Beecham, recently adopted on the Chicago, Milwaukee and St. Paul Ry. 1400 w. Ry Age—March 25, 1898. No. 19191.

Earnings.

February's Good Railroad Earnings. Report for the month giving comparative tables. 1800 w. Bradstreet's—March 12, 1898. No. 18943.

Pennsylvania's Year of Improvement. Synopsis of report for 1897, with editorial. 4000 w. Bradstreet's—March 5, 1898. No. 18796.

Graphic Records.

Graphic Methods as Applied to Railway Records. Tracy Lyon. Read before the Northwest Ry. Club. Describes the method and demonstrates its value. 1800 w. Ry & Engng Rev—March 26, 1898. No. 19192.

LEGAL.

Coupler Decision.

The Latest Car Coupler Decision. Decision of the U. S. Circuit Court of Appeals in the case of the St. Louis Car Coupler Co. vs. the National Malleable Castings Co. over an alleged infringement of patents. Ill. 2000 w. Ry Age—March 25, 1898. No. 19190.

Freight.

The Law Respecting Freight for the Carriage of Coal. British law concerning the principles relating to contracts of affreightment, illustrated by cases. 4000 w. Col Guard—March 4, 1898. No. 18953 A.

Ireland.

Irish Railway Property. Information upon the finances of the three trunk companies which represent largely the railway network of the country. 1400 w. Engng—Feb. 25, 1898. No. 18868 A.

Nebraska Case.

Has the Supreme Court Pronounced the Nebraska Law Unconstitutional? Editorial discussion of Justice Harlan's decision. 1800 w. R R Gaz—March 18, 1898. No. 19000.

MOTIVE POWER AND EQUIPMENT.

Bogie Truck.

Discussion of a Bogie Truck for Passenger Cars on the Great Western Railway of England. George L. Fowler. A complete set of illustrations of a bogie truck for passenger cars that is built at Swindon, Eng., with discussion of the design. 6600 w. R R Car Jour—March, 1898. No. 18919.

Car Construction.

Car Designing and Construction. A. M. Waitt. Abstract of a lecture before the engineering students of Purdue University, dealing with the design of freight cars. 1000 w. Ry Age—March 25, 1898. No. 19189.

Coal Cars.

New Coal Cars of 80,000 lbs. Capacity—Illinois Central Railroad. Illustrated detailed description of low-draft coal cars. 800 w. Ry & Engng Rev—March 12, 1898. No. 18991.

Concord Shops.

See Permanent Way and Fixtures.

Freight Cars.

Springs for Freight Car Trucks. H. C. McCarty. Committee report of results of investigation of the question of "Coil Springs for Freight Car Trucks." Ill. 1800 w. Cent Ry Club—Jan., 1898. No. 18765 D.

Electric Locomotive.

Austrian Narrow Gauge Electric Locomotive. Illustrates and describes a locomotive built for the brewery of Dr. Schaub, intended for hauling two or three freight trailers, as well as conveying passengers, back and forth from the brewery to the railroad station. 1100 w. Elec Eng, N. Y.—March 3, 1898. No. 18763.

Grate Area.

How Large Can Grate Area Be Made Advantageously? Editorial discussing the action of the Erie Railway Co. in employing engines with Wootten fire-boxes over the main line of their system. 1400 w. Loc Engng—March, 1898. No. 18740 C.

Headlights.

Electric Headlights for Locomotives. Discussing the advantages and the objections. 1600 w. R R Gaz—March 11, 1898. No. 18940.

Instruction Car.

The Michigan Central Air-brake Instruction Car. W. W. White. Illustrated description. 600 w. Loc Engng—March, 1898. No. 18742 C.

Locomotive Handling.

The Economical Handling of Locomotives. Eugene McAuliffe. Observation and experience of the writer, with suggestions for lessening the

cost of operation of locomotives. 1200 w. Loc Engng—March, 1898. No. 18741 C.

Locomotives.

A New Express Engine on the Caledonian Railway. Charles Rous-Marten. Particulars of a new express engine of excellent design, the work of J. F. McIntosh. Ill. 2000 w. Engr, Lond—Feb. 25, 1898. No. 18857 A.

Economical Locomotives. G. W. Rhodes. Extracts from an address at a recent meeting of the St. Louis Railway Club, on the economical locomotive and its relation to the track. 1300 w. Am Eng & R R Jour—March, 1898. No. 18751 C.

Evolution of the Locomotive. John S. Thurman. History of the locomotive with illustrations showing the advancement. 6800 w. Ry Mag—Jan., 1898. No. 18759.

Four-cylinder Locomotives, and the Expansion Ratio for Compound Engines. (Viercylindrige Lokomotiven und die Füllungsverhältnisse bei Verbunddampfmaschinen.) Inspector Leitzmann. With many diagrams, and a general analytical investigation of the conditions of expansion in compound locomotives. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 1898. No. 19249 D.

Ten-Wheel Passenger Locomotive; Atchison, Topeka and Santa Fé Ry. Description with dimensions and two-page plate. 1100 w. Eng News—March 3, 1898. No. 18770.

The Construction of a Modern Locomotive. Part first is introductory to a series of articles dealing with the modern methods of construction of a machine capable of the higher speed, greater trainload, and other requirements made necessary by close competition. Ill. 3800 w. Am Eng & R R Jour—March, 1898. Serial. 1st part. No. 18749 C.

Twelve-Wheel Locomotive—Chicago and Eastern Illinois Railroad. Half-tone and side elevation with general dimensions and particulars. 700 w. Loc Engng—March, 1898. No. 18739 C.

Utility and Characteristics of Locomotive Laggings. Wallace W. Johnson. Considers the subject of non-heat-conducting boiler and cylinder laggings and the loss of heat by radiation. Also discussion. 8500 w. N Y R R Club—Feb. 17, 1898. No. 18976 D.

Motor Car.

The Baldwin Motor Car for the C. H. & D. Traction Company. Illustrated detailed description. 400 w. R R Gaz—March 4, 1898. No. 18797.

Speed Trials.

Notable Speed Trials of British Locomotives. Charles Rous-Marten. A fully illustrated account of British high-speed locomotives with records of speed trials, showing the manner in which records in England have been made and broken under the stimulus of competition. 4500 w. Engineering Magazine—April, 1898. No. 19296 B.

Tools.

Special Tools; Fitchburg (Mass.) Car Shops. The application of compressed air for the operation of various tools is described, and other

economical methods of doing work. Ill. 2300 w. R R Car Jour—March, 1898. No. 18920.

Train Lighting.

The Electrical Lighting of Mail Cars. (Die Elektrische Beleuchtung von Bahnpostwagen.) Editorial comments on the results of accumulator lighting during four years' experience in Germany. The lamps are changed after about 200 hours' use. The cost is about $3\frac{1}{2}$ pfennigs per lamp hour at 12 candle power. 1200 w. Elektrotech Zeitschr—Feb. 24, 1898. No. 19267 B.

Train Resistance.

Train Resistance. A discussion of this subject, especially of the way in which it varies with the speed. 2300 w. Engr, Lond—Feb. 18, 1898. No. 18722 A.

NEW PROJECTS.

Africa.

Railway Building in German East-Africa. (Eisenbahnbau in Deutsch Ostafrika.) With map, profiles and an account of existing and proposed work; the roads will ultimately connect the Zanzibar coast with lakes Tanganyika and Victoria Nyanza. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1898. No. 19246 D.

China.

Modern China from an Engineer's Point of View. Part first considers railways and railway projects, reviewing the steps already taken. Ill. 3000 w. Engr, Lond—March 18, 1898. Serial. 1st part. No. 19163 A.

Railway Prospects in China. Editorial review of the progress being made. 3400 w. Engng—March 18, 1898. No. 19169 A.

Extension.

The Crows Nest Pass Extension of the Canadian Pacific Ry. An account of a line being built to open communication between the mineral regions of British Columbia and the Canadian Pacific system. Map. 1300 w. Eng News—March 10, 1898. No. 18911.

Lagos.

Lagos. Interesting information of this British colony of West Africa, and of the railway in process of construction. Ill. 3700 w. Engr, Lond—Feb. 25, 1898. No. 18859 A.

Madagascar.

The Madagascar Railway. (Le Chemin-de-Fer de Madagascar.) Editorial discussion of the need of railway communication in the new colony, with estimates of cost and statements of the valuable developments which would follow. 1200 w. Moniteur Industriel—Feb. 19, 1898. No. 19241 G.

New Trunk Line.

A New Trunk Line to New York. Discusses a proposed line from Chicago to New York. Map. 700 w. Ry Age—Feb. 25, 1898. No. 18707.

Uganda.

The Uganda Railway. An interesting general account of the line. 2500 w. Ind Engng—Feb. 19, 1898. No. 19152 D.

PERMANENT WAY AND FIXTURES.

Boston Station.

The Back Bay Station of the New York, New Haven & Hartford at Boston. Illustrated description of interesting features, with general information. 1500 w. *R R Gaz*—March 18, 1898. No. 18996.

China.

The Northern Railways of China. (*Die Nördlichen Chinesischen Staatsbahnen.*) With illustrations of bridges, tunnels, and rolling stock of the Tientsin-Peking railway, and the Kaiping coal mines and coke ovens. 2500 w. *Zeitschr d Oesterr Ing u Arch Ver*—Feb. 25, 1898. No. 19258 B.

Concord Shops.

Concord Shops—Boston & Maine Railroad. Some of the features of the locomotive shops and planing mill. Plans of the buildings, and also views of interiors including the powerful electric traveling cranes, are also given. Ill. 3800 w. *Am Eng & R R Jour*—March, 1898. No. 18748 C.

Mountain Road.

The Railway from Fayet to Chamounix. (*Le Chemin de Fer du Fayet à Chamonix.*) Illustrated description of combined adhesion and rack railway, opening communication by rail from Geneva to Chamounix, and from the latter to the Swiss frontier. 2500 w. *La Revue Technique*—Feb. 10, 1898. No. 19200 D.

Puebla Station.

Puebla Station, Interoceanic Railway of Mexico. Plan of the Puebla Yard and view of the recently completed station with brief remarks. 400 w. *Ry & Engng Rev*—March 26, 1898. No. 19194.

Rack.

Recent Rack Railways. (*Neuere Zahnradbahnen.*) E. Brückmann. Illustrated descriptive account of some of the latest roads and rolling stock, including the Damascus, Snowdon, Berner, Wengernalp, Gaisberg, Padang, Gornergrat, Jungfrau and other roads. Serial. 3 parts. 1 plate. 6500 w. *Zeitschr d Ver Deutscher Ing*—Feb. 12, March 5, 12, 1898. No. 19243 each D.

See also Street and Electric Tramways.

Rails.

Rails and their Resistances in Railway Service. (*Du Rail et sa Résistance dans les Voies.*) G. Vinot. A discussion of the rail as a manufactured product, of its strength, and its capacity to resist the various shocks and stresses to which it is subjected. Serial. Part 1. 2500 w. *La Revue Technique*—March 10, 1898. No. 19211 D.

Road Bed.

Improvements in the Permanent Way of the Railways of Germany. (*Zur Verbesserung des Oberbaues auf Deutschen Eisenbahnen.*) A paper by Prof. Goehring before the railway society with illustrations of improved fastenings, rail joints and track construction. Serial. Part 1. 8000 w. *Glaser's Annalen*—March 1, 1898. No. 19280 each D.

Signalling.

Operation and Maintenance of the Block System on Single Track; C., N. O. & T. P. Ry. W. A. D. Short. Abstract of a paper read at the Pittsburg meeting of the Ry. Signalling Club. Considers the combination of the telegraphic block and the automatic electric block; also the electric train-staff system. 4000 w. *Eng News*—March 10, 1898. No. 18910.

Snow Protection.

The February Snow Storm in Massachusetts. George W. Blodgett. Calls attention to the great damage done by this unusually heavy storm, and suggests the placing of the railroad wires underground, as rapidly as possible. 1800 w. *R R Gaz*—March 25, 1898. No. 19113.

Statistics.

The World's Railways. Diagram showing the distribution of the railways of the world, with explanation. 500 w. *Engng*—March 18, 1898. No. 19167 A.

Terminal Facilities.

Improvement of the Terminal Facilities at the Port of New York. Criticisms on the plans proposed for facilitating the interchange of goods between ships and systems of land transportation, with lengthy editorial. 4400 w. *Eng News*—March 10, 1898. No. 18907.

Terminal Improvements at Quincy, Ill.; Chicago, Burlington & Quincy R. R. Plan, showing the situation, with explanatory notes. 1300 w. *Eng News*—March 17, 1898. No. 19025.

The Railroad on West Street, New York. Discussing the scheme presented to the Dock Commissioners. A criticism of C. W. Buchholz. Extracts from an article published in the *N. Y. Journal of Commerce*. 1800 w. *R R Gaz*—March 4, 1898. No. 18798.

TRAFFIC.

Pooling.

Pooling—Fancies versus Facts. Editorial discussion of the address of George F. Stone, secretary of the Chicago Board of Trade. 1500 w. *Ry & Engng Rev*—March 26, 1898. No. 19195.

Railroad Pools. W. W. Knight. Part first gives a brief review of railroad history, the disastrous results of rate "wars," and the effect of pools in keeping the rates steady. 2000 w. *Yale Sci M*—March, 1898. Serial. 1st part. No. 19012 C.

Railway Regulation.

A Decade of Railway Regulation. Henry C. Adams. A review of the ten years' experience with the federal Act to regulate commerce. 6400 w. *Atlantic M*—April, 1898. No. 19080 D.

Rates.

See Street and Electric Tramways.

Standard Code.

Standard Code on the Southern Pacific. Calling attention to some of the rules in the revised edition recently issued for the operating department. 1000 w. *R R Gaz*—March 18, 1898. No. 18997.

STREET AND ELECTRIC TRAMWAYS.

Brake.

Adhesive Rail Brakes. (Adhäsion Vermehrende Schienenbremsen.) Max Schiemann. Describing a form of tramway brake acting by the adhesion of magnetized brake shoes directly to the rails. 1000 w. Deutsche Zeitschr f Elektrotechnik—March 15, 1898. No. 19273 H.

Brooklyn Elevated.

Electrical Equipment of the Brooklyn Elevated railroad. The system to be used, and illustrated description of the Short motors, showing the method of suspension, and the relations between motor and truck. 1400 w. Elec Eng, N. Y.—March 3, 1898. No. 18762.

Commutators.

Commutator Segments for Electric Traction Apparatus. Frank X. Cicott. Presents the difficulties in this field and the improvements made, giving the accepted use of the largest consumers. Ill. 1500 w. Ry Wld—March, 1898. No. 18967 A.

Dayton, Ohio.

The Street Railways of Dayton, Ohio. An illustrated account of the railways which are under the control of three distinct companies. 3800 w. St Ry Jour—March, 1898. No. 18800 D.

Elevated Roads.

Electric Traction on Elevated Railways. (La Traction Electrique sur les Chemins de Fer Elevés.) A discussion of the applicability of an electric elevated railway for Paris, based on the experiences of Chicago, New York and Brooklyn. 3500 w. 1 plate. La Revue Technique—Feb. 25, 1898. No. 19205 D.

Feeders.

Electric Railway Feeders. George T. Hanchett. On the calculation of steel feeders. 1200 w. Am Elect'n—March, 1898. No. 18831.

Glasgow Subway.

Glasgow District Subway. Data and illustrations relating to this underground passenger cable railway. 1800 w. St Ry Rev—March 15, 1898. No. 19044 C.

New England Railway.

A Recent New England Railway. An illustrated description of the new line connecting Torrington and Winsted, Conn. 5000 w. St Ry Jour—March, 1898. No. 18803 D.

Paris.

Electric Traction in Paris. (La Traction Electrique à Paris.) Emile Dieudonné. Giving profiles of suburban lines out of Paris and description of accumulator and trolley motor cars soon to be installed. 3000 w. 1 plate. La Revue Technique—March 10, 1898. No. 19207 D.

Polyphase Motors.

Polyphase Current Motors for Railways. (Drehstrombahnen.) Max Schiemann. A dis-

cussion of the applicability of polyphase currents for railway service and a description of the application to the Jungfrau mountain-road. 2500 w. Deutsche Zeitschr f Elektrotechnik—Feb. 15, 1898. No. 19272 H.

Power Plant.

Test of the Brockton Street Railway Plant. Illustrates a plant representing the most advanced practice and describes an unusually complete test. 1800 w. Eng Rec—March 5, 1898. No. 18895.

Rail Bonding.

Rail Bonding as a Power Saver. H. C. Chase. Read at the Texas-Mexico Convention. Considers that rail bonding as a power saver depends upon the bonds being of ample capacity, perfect connections and large contacts. 1100 w. St Ry Rev—March 15, 1898. No. 19048 C.

Rapid Transit.

Rapid Transit in New York. A synopsis of the franchises which the N. Y. Rapid Transit Commissioners offer to the Manhattan Ry. Co. 1200 w. R R Gaz—March 25, 1898. No. 19115.

Rates.

Freight and Passenger Rates on Interurban Lines. Latest views of street railway managers on this subject. 2800 w. St Ry Rev—March 15, 1898. No. 19046 C.

Salt.

The Use of Salt. The question as to whether street railways may be permitted to use salt, as brought forward in Binghamton, N. Y. 1800 w. St Ry Rev—March 15, 1898. No. 19045 C.

Snow Storms.

Story of the Great Storm. A record of the fine work on various street railways in New England in opening the lines, giving valuable experiences. Ill. 9800 w. St Ry Rev—March 15, 1898. No. 19043 C.

Street Railways.

The Relations Between Municipalities and Street Railway Companies. Editorial on the report of the committee appointed by the governor of Massachusetts to consider these relations. 3000 w. Ry & Engng Rev—March 12, 1898. No. 18992.

Surface Contact.

Kingsland's Surface Contact System of Electric Traction. Illustrated description of the apparatus and method of working of this system. 1600 w. Elec Rev, Lond—March 18, 1898. No. 19158 A.

Vienna.

The Operation of the Vienna City Railway. (Der Betrieb der Wiener Stadtbahn.) Gustav Gerstel. A discussion of the first year's operation of the Vienna elevated railway, with especial reference to speeds, signals, and the distribution of transportation. 7500 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 25, 1898. No. 19256 B.

THE
ENGINEERING MAGAZINE

VOL. XV.

JUNE, 1898.

No. 3.

FUTURE INDUSTRIAL OPPORTUNITIES IN
CUBA.

By Wilfrid Skaike.

THE coming change in the government of Cuba will naturally attract the attention of the engineering and contracting world to the development of the resources of that country, and the writer desires to point out as briefly as may be some possibilities for a successful exercise of energy and the investment of capital, and, as well, to speak of the darker side of Cuban industrial life.

A great deal of valuable statistical information about Cuba may be gleaned from encyclopedias and foreign consular reports, and much sentimental information of no value from the American dailies.

In the first place, intending settlers and investors will do well, in trying to avail themselves of the undoubted opportunities the island offers, to consider the moral degeneration of the people, who will be slow to learn that honesty and fair dealing are possible in business transactions.

The administration of justice is a perfect farce, and the wholesale open corruption in the custom house is probably unequalled elsewhere. Special commissioners to levy special taxes constantly appear without warning on the scene, being always political friends of the Spanish government officials, and these men are regularly "squared" by the victims to keep quiet or issue false reports. Tricks and schemes to make money dishonestly abound in all walks of life, except perhaps among the ordinary labourers, who are sober, industrious, peaceable individuals enduring mighty hardships at the hands of their infernal government.

This state of affairs will not be cured in a day. Many a

Copyright, 1898, by John R. Dunlap.

Spaniard and Cuban bitterly deplores the present abominable *régime*, but the power of the better men is swamped by that of the more unscrupulous. The writer has entire faith in an ultimate bright future for Spain and Cuba, when some western light shall shine through the present darkness and the people have half a chance to educate their children and take some real part in the government of their country; but chaos will surely come first, and industrial pursuits will suffer for a time.

The various directions in which industrial and engineering works may be carried out may be generally stated to be the same as those which present themselves in any new country, in spite of the fact that Cuba is the oldest settlement in America. It is a bitter comment on Spanish rule to point out that common roads for wheeled vehicles hardly exist, except in the near vicinity of the larger towns. What is known as a Camino Real (Royal Road) is merely a broad strip of country, sometimes fenced by cactus and barbed wire, and passable on horseback or by ox-carts in the dry season. The only time, in fact, in which hauling can be done to any extent is during the long dry season, when the field roads made by the sugar and tobacco estates can be traversed by great two-wheeled carts with four oxen. Two days of rain stops traffic in all directions. The opportunity for the building of common roads is larger, and in most places there is plenty of stone for the purpose.

The roads cross rivers, etc., by fords which are impassable soon after the rains set in, and, although the streams are neither large or very numerous, the necessity for bridges is great.

Means of rapid transport exist in the shape of railroads and coasting steamers. The former are fairly well equipped, but are operated only in the daytime and at a rate of speed which is not what other countries are accustomed to to-day. They extend through the western provinces of Pinar del Rio, Havana, Matanzas, and Santa Clara, in various directions, and two short lines extend from the north and south coasts into Puerto Principe. A glance at the map will show that the great bulk of the island to the east of Santa Clara is yet untouched. Part of the region is still unexplored.

On the various sugar estates narrow-gauge roads are in extensive use for the handling of cane, and often form means of communication with the interior in connection with coasting steamers and the broad-gauge roads. These narrow gauge roads are of much greater extent than might be supposed. The large estate called Constostia, for instance, has more than forty miles of such road, and many have more than twenty miles. The handling of cane and its development will be dealt with further on, when the sugar industry is considered.

No electric roads exist in Cuba at the present time, but their immediate institution may be looked for. It is a singular fact that the travel on the various coasting steamers, on the vessels running up the small rivers, on the railroads, and on the few "busses" that run to suburbs of the larger towns, is very much larger than one would expect from the apparent nature of the people and their means. The writer has constantly been surprised at the over-crowding of these means of travel, and understands, on the best of authority, that the business is a very paying one indeed. The rates charged are usually exorbitant, but the travel goes on even when the possibility of being dynamited *en route* adds to the general discomfort.

The writer travelled last winter on a train with pilot engines in front, an armoured car behind, and amid the liveliest rumors of trouble on the road, and, though there were few first-class passengers, the other cars were filled with people travelling. God knows why! The extension and improvement of steam railways, opening up the country and giving better service, is sure to be a very paying business in the future, while there are a number of towns in which electric roads could be run to advantage, besides Havana itself.

Municipal improvements will also give much work in the future to engineers. First among these is the drainage of the towns. The sewers, where any exist, are horrible things, built without the most elementary knowledge, in which the congested filth of years breeds disease and vile odours. Means of flushing them do not exist, and undoubtedly the more apparently filthy system of dumping house refuse, and emptying substitutes for water closets, along the curb stone is less dangerous to health than such a sewerage system. To this abominable condition of the towns may be traced the prevalence of fevers, small pox, and dysentery in Cuba. These diseases are uncommon in the isolated estates, and may, the writer firmly believes, be almost entirely eliminated from the island by giving attention in the towns to the most ordinary rules of sanitation.

Another and equally important necessity in Cuban towns is water. Havana is pretty well supplied, but in most other towns there is very little or none besides the rain water stored during the wet season, in great stone cisterns beneath the houses. It is not that the people in general do not fully appreciate the necessity and luxury of water, but that the executive power is lacking. Taxes are raised for this purpose, and special taxes are sometimes levied to build new works or for coal to keep the pump going, but (and this may serve as instance of many transactions) the money is calmly banked to the credit of the officials, or the coal is bought and resold for their benefit. Water is wanted terribly in the towns during the dry season, and may

easily be had. Excellent springs abound in most places, and small rivers of good water are fairly common.

Connected with the cities and towns may be cited harbour improvements. Cuba is the land of fine harbours. Havana, Matanzas, Santiago, Guantanamo, Cienfuegos, and many other less important spots have splendid harbours, and, with the exception of Matanzas, which is wide at the mouth, the entrances are so narrow that inside they resemble inland lakes in appearance and calmness. But there their usefulness ends, for no piers or wharves worthy of the name exist for sea-going vessels.

Almost all loading and unloading is done by means of lighters. Money indeed is collected for the construction of piers and the dredging of approaches to them, but no work is done, for a very profitable understanding seems to exist between the owners of the lighters and the city governments on these points.

Such a condition of things cannot continue for very long. In a prosperous season Cuba ships a million tons of sugar alone, and surely, under a half-enlightened government, this is worth an occasional pier.

To turn to the great industries of the country,—those that have made Cuba's reputation for wealth, and justly so,—two far outclass the rest,—namely, the production of sugar and of tobacco. Apart from these there is the production of fruit,—mostly bananas,—of coffee, and of iron, that of coffee and of iron being of small extent and confined to the province of Santiago. Incidental to the growth of the sugar industry and the demands of the towns there is the herding of cattle, a considerable and very profitable industry in times of peace.

What the iron and copper deposits may amount to it is now impossible to say, but that both exist in paying quantities is undoubted.

Two considerable iron deposits are now being worked successfully, close to the town of Santiago, by American companies; one other, the *Signa M. Co.*, was started on a large scale, but abandoned soon, as the ore was on the surface only.

Copper mines in the coast range near Santiago were worked some years ago, but, the writer understands, were choked to death by excessive and special taxation.

In the total absence of any official reports on which the smallest reliance can be placed, the prospecting engineer must attack the problem of Cuban mining for the future from the very beginning. All one can say at present is that the field is a promising one. The ore deposits lie near the coast, and the large shipments of iron ore, even in these troubled times, attest its value in the eyes of American buyers.

However, the mining industries will be confined to the mountain-

ous parts of the coast at the eastern end of the island, while the great bulk of the land doubtless will be devoted to the growth of the sugar cane and tobacco plant, for it is certain that these two plants thrive to an extent in Cuba unknown elsewhere. It seems that the climate and the soil combine conditions very favorable to their growth and to their harvesting. These industries present radically different aspects. In the case of tobacco we have numbers of small cultivators, in the field, and great institutions where the rolling and packing and marking of the finished product is chiefly hand-work ; so that the chief elements of success are the employment of great numbers of men and women who have the necessary skill, at the lowest price, and the careful organization of them to insure their efficiency. The tobacco industry undoubtedly offers a good field for the investment of capital, and, further, is a ready way in which a man with small means and a little good land may make his land pay him well ; but it affords little scope for the engineer or contractor. Its great strength lies in the unrivalled quality of the leaf.

The sugar industry, on the other hand, affords a wide field for many kinds of enterprise.

Cuba, in times of peace, produces about one million tons of cane sugar, more than twice as much as Java, the next largest cane sugar country of the world, and more than five times as much as any other cane sugar country. Among the beet sugar countries it is surpassed only by Germany, with one and one half million tons, and is equalled only by one other, Austria. It must be regarded as a singular state of affairs that, while in all the other West Indian islands, and, in fact, in nearly all cane sugar countries, the industry is in a desperate state, warranting special commissioners to inquire into its illness and its needs, the Cuban industry has gone ahead and prospered under a government which pillaged it steadily, in spite of outrageous railroad freights, bad shipping facilities, the heart-breaking question of European bounties, and discrimination to its detriment by American buyers. The reasons why it has prospered are quite clear. First, the climate and soil are admirably adapted to the needs of the cane ; secondly, the Spaniards and Cubans have had the courage to centralize their sugar houses and go at the business individually, on a scale unequalled in any other country on the globe. Old, small places were replaced by powerful factories equipped with the best of modern machinery, narrow-gauge roads were built in all directions, and, in short, great sums were spent, and spent well. The main essentials of competing with the beet sugar countries were understood and complied with, while in the other islands they are still hesitating.

It is not within the scope of an article like the present to go into the

details of sugar manufacture, but I may briefly point out that, first, great tracts of land are available for sugar cane which are yet a wilderness, and, secondly, that in the cultivation of the cane, both in the preparing of the land and in the planting and harvesting, there is a crying need of machinery. The planting of the cane is nearly all done by hand. There are a few cane-planting machines, but little is known about them. The weeding is done by hand in the majority of instances, and finally the harvesting is done with a knife, and a laborious business it is. It takes five hundred men per day to cut the cane alone, on a large estate, to say nothing of loading and teaming to the railroad tracks; and the man who can successfully solve the problem of a cane harvester has a large field to work in.

The machinery used in the manufacture of sugar on a large estate is very extensive. A large "Central" will grind 1,000 tons of cane in 24 hours, or, say, 100,000 tons in a season of 100 days. A boiler capacity of 1,200 to 1,500 h. p. is necessary to do this, nearly all of which power is used for driving the various pumps and engines, the evaporation being performed by the exhaust steam. Such an establishment is worth in Cuba about half a million of dollars, and its annual output is worth about the same amount. Three or four locomotives and about one hundred cars are necessary to haul the cane, and about 1,000 men altogether are employed in the field and in the works. Besides, one to two thousand head of cattle for hauling and slaughtering are needed. There are very many such establishments in Cuba, and there is room for more.

The supplying of the sugar houses with new machinery has been an enormous business in the last decade. It has been in the hands of the Scotch, French, and American machine houses mostly, as the German and other continental houses have fought shy of the long credits demanded, the insufficient security, and the general lack of good faith in Cuban business affairs. There can be no doubt that much new business in this direction must spring up with the settlement of the present dispute, and it will doubtless gain in security with time.

In looking at the future development of Cuba we have to consider the question of labour. This is of three kinds,—white, black, and yellow. The white labour consists of native Cubans, natives of the Canary islands, and Spaniards, of which the latter are far the best for general work.

After some experience in many countries, I have yet to see a harder-working or more peaceable lot of men than the native Spaniards.

The Canary islanders and the Cubans are less sturdy and less trustworthy, but, especially in the case of Cubans, more intelligent. The blacks are a strong, vigorous race, having much more of the savage in

them than those in the southern States or Jamaica. They resist the enervating influences of the climate far better than the whites, and are better field hands, but dull to a degree. The Chinese are all old men, brought there in slavery times and still practically slaves, as they work entirely by contract. You employ a "Capataz," as he is called, and he furnishes you so many men to do so much work every morning at so much per man. These men are wonderfully steady, and do work out of all proportion to their strength, but their strength is very little.

The pay of the common labourer varies very much with the times. In the active season he gets about 15 Spanish dollars per month and his food and board, both of the roughest kind. It costs about 7 dollars per month to feed a man where the men are best fed, and considerably less at other places. At the present time the pay has run down in the dead season to \$10; indeed, in many places men work for their food alone.

The Spanish silver dollar is worth about 65 cents, so that you get very good labour for about \$15 a month, American currency. The pay of mechanics ranges from 40 to 100 dollars per month, according to ability.

Among industries which have received very little attention as yet, the fruit industry may be mentioned. Extensive banana plantations exist on the north coast, and fine apples are produced, but one great destructive influence, that of the cyclone, is to be counted with in growing fruit. Still, the business is said to be profitable, and certainly admits of great extension, and perhaps of an improvement in the kind of banana used for export. The more delicate kinds should find a great sale in the north, should some one succeed in getting them there in good condition.

Other tropical fruits, oranges, lemons, mangoes, alligator pears, guavas, etc., grow wild and in extraordinary abundance, but almost nothing has been done to produce them commercially. The soil of Cuba is one of the most fertile soils in the world.

The climate of Cuba has been much maligned, but not in the right way. Yellow fever and very bad kinds of malarial fevers certainly exist, as well as small pox, but almost solely in the larger towns, where, as has already been stated, the sanitary conditions are abominable. In the open country few people are attacked, and these few only in the wet season. The seasons are sharply divided into the dry one, from about November 1 to about May 15, and the wet one, the remainder of the year. The total rainfall is about 50 inches, and occurs mostly in the fall months. At no time is the heat very great, nor is frost known, except at considerable altitudes, the extremes being about 45° and 95°. The nights are always cool, and in the winter time a

more delightful climate does not exist. But of its enervating influence there can be no doubt. It is to be seen in every man who spends a few years continuously on the island, and is to be seen in white children born there.

Let the northern man who embarks in any enterprise there provide a long holiday every year, or he will rue it surely.

We have now to consider, as an offset to the pleasant side of the picture, four great destructive influences that have to be counted with in Cuba. They are drought in the winter time, cyclones, fire, and revolutions. The first-named is not very frequent; the second occurs in the fall and about every two years; the third is the great enemy of the cane, which, being full of dry trash, is most inflammable; and the fourth may be expected about every ten years. All of these, including the latter, must be carefully taken into account. Peace is not for Cuba for years to come.

Fire in the cane is a very serious matter. The success of the insurgents is greatly due to the power of destruction which lies always at their hand in this direction. A cigarette stump on a windy day will burn a thousand tons in an hour, and force the planters to cut and haul the cane inside of a few days, or lose it by fermentation of the juice.

Even in times of peace armed and mounted men are needed to patrol the fields and watch the workmen, while in times of revolution, like the present, it costs an estate thirty to fifty thousand dollars a year to defend its fields. This is the history of the past and present time, and the writer cannot think that there will be a speedy change.

The whites control the island, and outnumber the colored races. There may be trouble yet between the races, but the whites will win in any struggle, and preserve the island from the fate which has overtaken Jamaica, San Domingo, and others. The domination of the blacks means industrial and political death. Infinitely better would it be for the island to continue under its present misrule than to pass under the control of the negro, as all who have lived among a mixed population can testify. Any investor or settler in Cuba must, from the beginning, fight heart and soul against anything that will give power into the negroes' hands, for they will use it mercilessly against the whites.

MECHANICAL OPERATIONS IN THE MANUFACTURE OF A GREAT NAVAL GUN.

By Edwin J. Prindle.

A STRIKING feature of modern engineering development is the rapid overlapping of the provinces of military and civil work, using the latter term in its broadest sense. This is especially true of naval construction; and to England, which can be attacked only by sea, and to the United States, with its enormous coast line, the navy is a vital portion of the military establishment.

The modern ship of war is a huge aggregation of machinery, demanding the highest engineering skill for its creation and management. And this is true not only of the hull and the main and auxiliary machinery, but of the engines of offence and defence of which the great gun is the heaviest unit. It is a product of machine-building on the largest scale, proportionate to its importance in the fighting force of the vessel which carries it.

The smaller guns fire more rapidly than the big guns; but their shot can be effective only on the weaker parts of an armored vessel. The torpedo is deadly in its effects, when it succeeds in striking; but, if it is seen in time, the rain of shot from the rapid-fire guns will explode it at a safe distance, and, even if the torpedo escape this danger, it may be stopped by the torpedo nets which surround the vessel attacked. But the big gun of the navy in its largest size—thirteen-inch bore—is capable, under favorable conditions, of penetrating the heaviest armor afloat. It is the only weapon against whose attack there is no protection.

It is of interest, then, to inquire how the present form of big gun originated, what are its parts and operations as a machine, and by what processes it is constructed.

The big guns of the American civil war were almost entirely smooth-bore cast-iron cannon, which fired a spherical shot. The pressure which such a gun could resist was small, and the range was consequently short. The cast-iron guns, on account of their low power, could penetrate but a few inches of wrought iron; and, as the thickness of the armor was increased and greater toughness and hardness given to it, the construction of stronger guns became a necessity. A mere increase in thickness, beyond a certain limit, of the walls of a single-piece gun does not increase its strength.

The spherical shot could crush in the side of the old wooden or lightly-armored vessels; but, with the advent of heavy armor, it became necessary to devise a means of penetrating the side of the vessel.

By elongating and pointing the projectile its action was confined to a small area with greater effect, and the penetration was thus secured. The change in the projectile caused a change in the gun. If fired from a smooth-bore gun, the elongated projectile would go end-over-end, exposing a great deal of surface to the air and striking anywhere but on its point. To keep the projectile end-on, spiral grooves were cut in the bore of the gun, and the projectile was furnished with projections which engaged the grooves, resulting in a rapid rotary motion which compelled it to travel point forward. But, the base of the projectile being of less area than that exposed to the pressure of the gases by a ball of the same weight, greater pressure in the gun and,



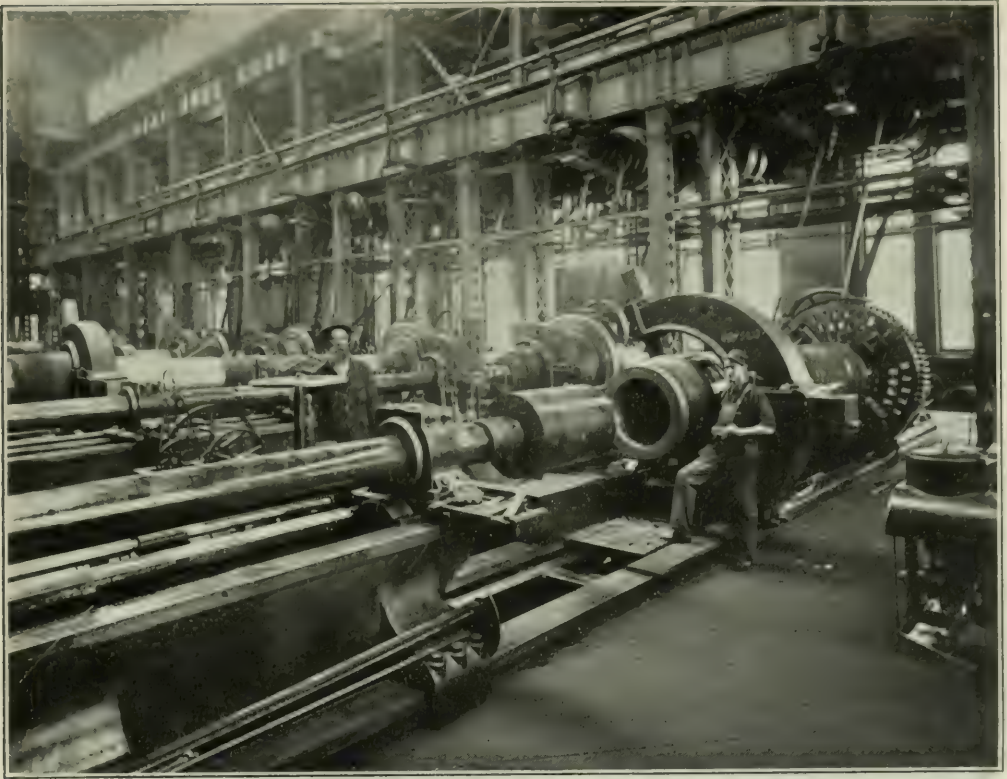
SECTION OF A 13-INCH GUN.

consequently, greater strength were required. It is desirable to further increase the pressure in the gun, in order that the trajectory, or line of flight, may be as flat as possible and the greatest accuracy and range be thereby secured.

To meet these severe conditions the big guns are now made on what is known as the "built up" principle, and of a length nearly three times that of the smooth-bore type. In the longer gun the gases have more time to act on the projectile before it leaves the gun, and, consequently, a slow-burning powder can be used, which, while it evolves the gas rapidly enough to keep up the pressure behind the projectile as it moves through the gun, avoids the needlessly great initial pressure of the quick-burning powder. The working pressure in a thirteen-inch gun of to-day is fifteen tons per square inch, and pressures as great as thirty tons per square inch have been recorded.

At first, owing to unskilful workmanship and use of material, the built-up guns were not successful, and a hundred shots was the average service of a big gun.

In the built-up gun the bore is formed in a tube of uniform diameter, and then several layers of hoops or bands are shrunk on, by making each part smaller than the one it embraces, expanding it by heat, and allowing it to cool in place on the gun. The parts of the gun, beginning with the tube, are in a state of compression, which decreases gradually outward until the outer layers are under tension. The pressure of the powder first overcomes the compression of the tube, and then puts it under tensile stress, at the same time being communicated to the outer layers, each of which bears its share. The shrinkage, or original difference in diameter between a hoop and the



BORING A JACKET.

The boring head on the boring bar is about to enter the jacket.

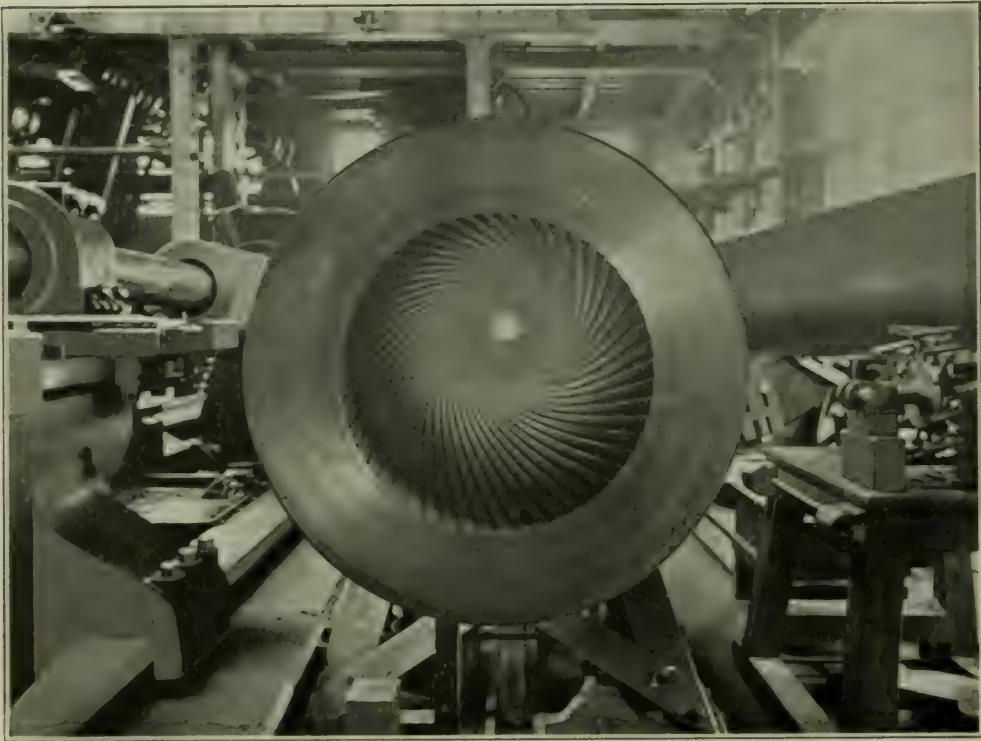
part on which it fits, is so calculated that the tube is not compressed beyond its elastic limit, nor is the outer hoop under such tension that it will pass the limit of its elasticity.

The foundation of the gun is a tube of uniform exterior diameter, which contains the powder chamber and the entire bore. A large sleeve called the "jacket," of about three-fifths the length of the tube, is shrunk on the rear portion of the tube, and extends enough farther to the rear to contain the breech mechanism. Three layers of "chase-hoops" are shrunk on the "chase," or portion of the "tube" extending from the jacket forward, and a locking band is screwed on the tube to hold the foremost chase-hoop in place. The jacket is embraced by a layer of "jacket-hoops." The chase-hoops interlock with the tube and with each other to prevent the forward portion of the tube from being blown apart from the rear portion; the jacket and forward jacket-hoop are similarly interlocked; and a locking band is screwed over the joint between the series of chase-hoops and the forward jacket-hoop to lock them together, thus effectually preventing the gun from breaking through transversely.

The thirteen-inch gun of the United States navy is forty feet in length and four feet in diameter, and weighs, unmounted, 145,000

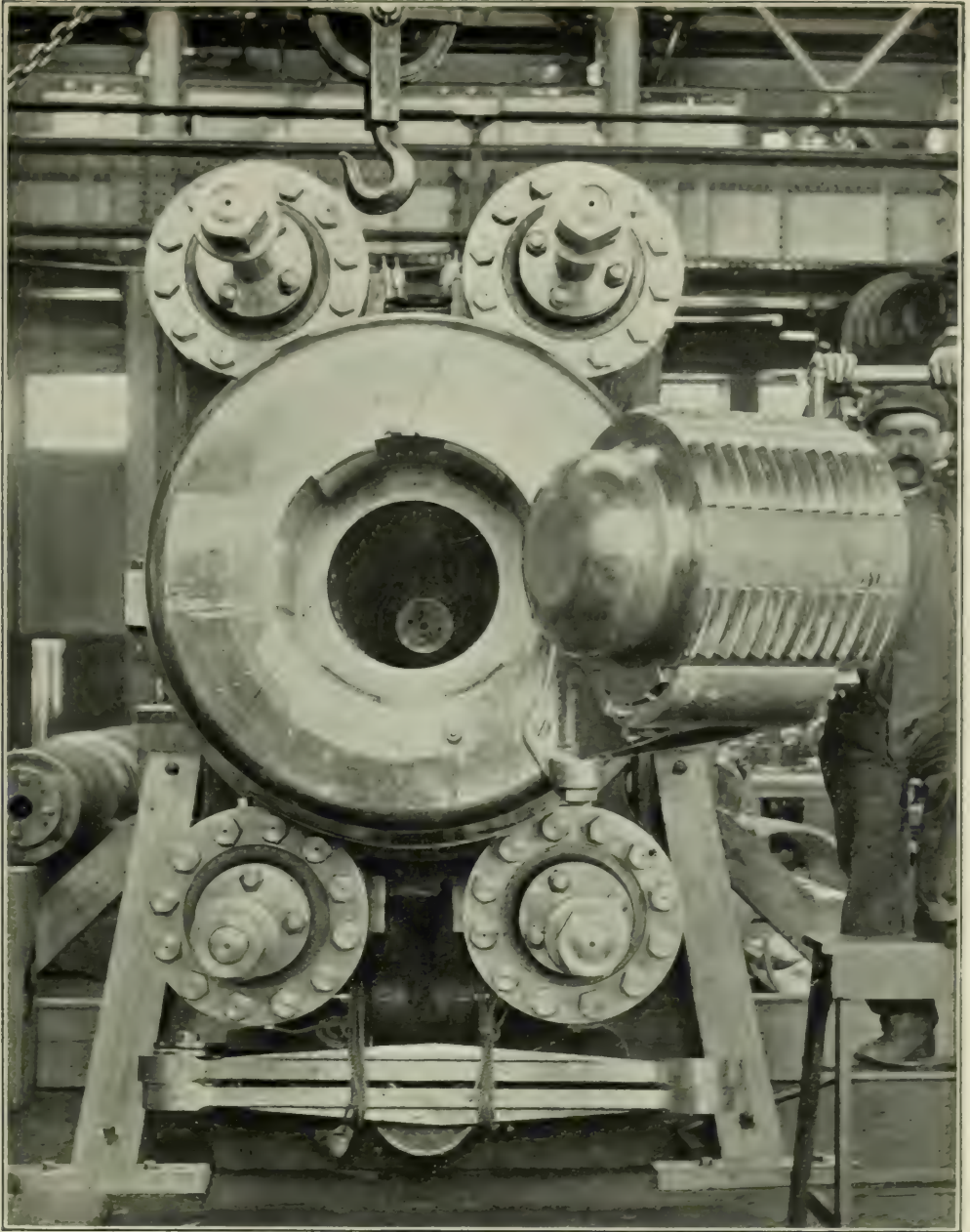
pounds,—a weight equal to that of a very powerful locomotive. The tube of the gun is two feet in diameter and thirty-eight and one-half feet long. The jacket is more than three feet in diameter and seventeen feet long. The bore is uniformly thirteen inches in diameter from the muzzle backward for four-fifths of its length, where it gradually enlarges to form the powder chamber.

The bore is provided with fifty-two rifling grooves, which decrease in width as they approach the muzzle. The grooves are straight forward at the rear of the bore, but gradually turn until, at



LOOKING INTO THE MUZZLE OF A 13-INCH GUN.

the muzzle, they give the projectile one turn in twenty-five calibres. In the overhanging portion of the jacket is the "screw box," into which is locked the "breech plug," which closes the rear end of the gun. The breech plug is cylindrical in form, and its surface is provided with a heavy screw-thread. The thread is cut away in six equal spaces. The cylindrical surface of the screw-box is correspondingly formed, so that, in screwing the breech-plug home, it is necessary only to place the thread sections on the block opposite the blank spaces of the screw-box, and slide the breech-plug clear in, when a turn of one-twelfth will engage the two systems of threads and lock the breech plug in place.

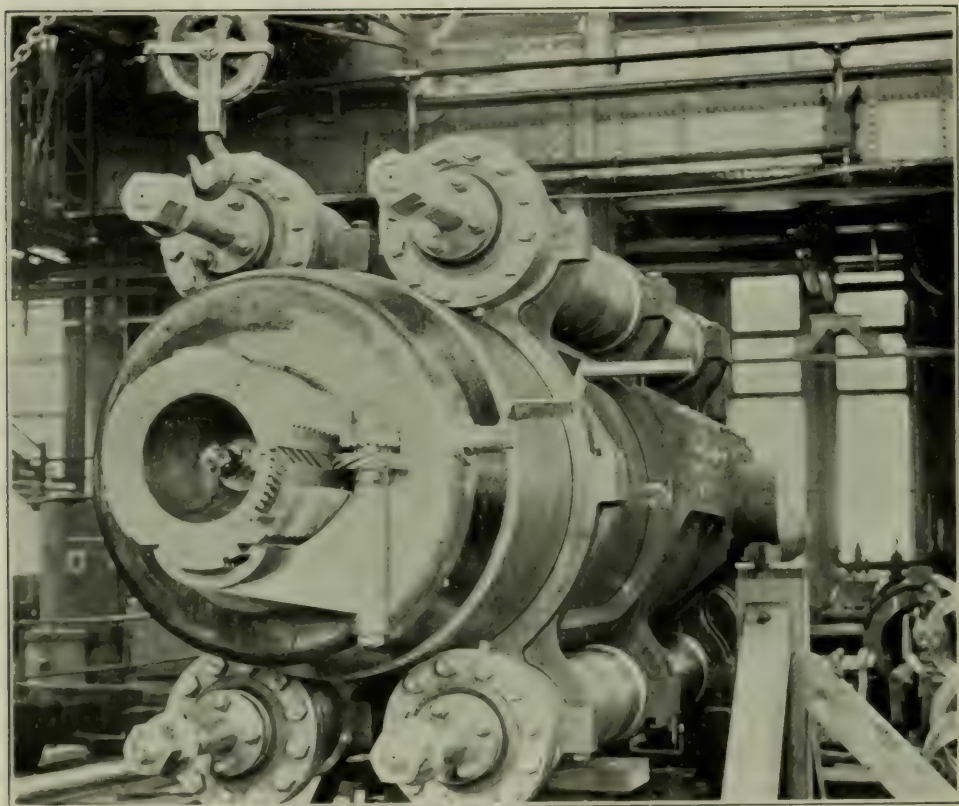


THE BREECH-PLUG SWUNG ONE SIDE.
The projectile may be seen in place in the bore.

The breech-plug, when out of the screw-box, is supported on the "plug-tray," which swings on a vertical shaft secured in bearings fixed on the rear end of the gun. The plug-tray has a guide-way to receive one of the screw-sections of the breech-plug as the plug slides out of the screw-box; and, when the breech-plug is entirely out of the gun, it is locked on the tray, and the latter swings on its shaft to carry the breech-plug to one side. All these motions are

performed simply by turning the shaft that supports the plug tray by means of a worm-wheel gearing and hand crank. On the shaft below the worm-wheel is a wheel which first acts (as a gear wheel) on a rack fastened on the breech-plug to slide the breech-plug into the screw-box, and then acts (as a worm-wheel) on a worm-rack at the end of the gear-rack to turn and lock the breech-plug in place.

Perfection of workmanship cannot be depended upon to prevent the gases from escaping between the adjacent surfaces of the breech-



BREECH-PLUG READY TO ENTER THE SCREW-BOX.

plug and screw-box under the enormous pressure of the explosion, and this necessitates a "gas-check." The "mushroom" (a piece of steel having the shape of the plant from which it is named) has its stalk secured in a central hole in the breech-plug. Its head nearly fills the slightly-flaring rear end of the powder-chamber, and between the head and the end of the breech-plug is a canvas ring filled with greasy asbestos. The explosion forces back the mushroom head, and squeezes the ring so that the passage is securely closed.

In the rear end of the mushroom stalk is secured either the spring lock or the electric-firing mechanism according to the method of firing the charge,—a lanyard (or cord), or electricity. The spring

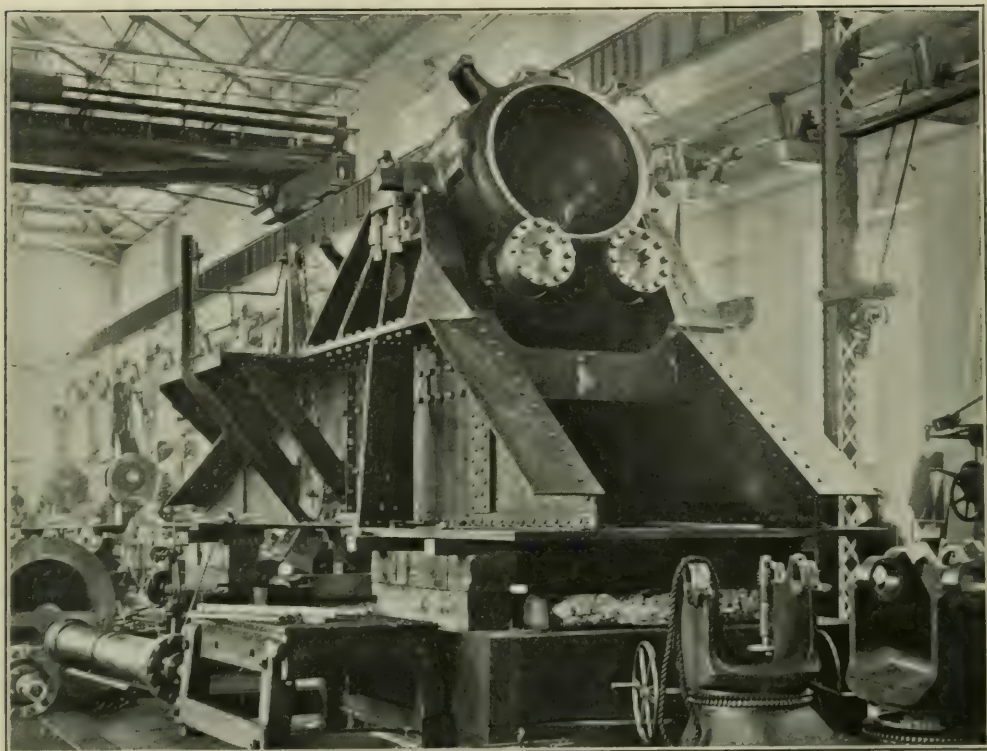


A GROUP OF 13-INCH PROJECTILES.

lock, in principle, is like the lock of a shot gun, having a firing pin (corresponding to the hammer of the gun) that is driven against a percussion cap in the primer by a spring when released by a pull of the lanyard on the trigger. The explosion of the percussion cap sets off a small charge of quick-burning powder in the primer, and the flame from the powder, escaping through a passage in the mushroom, reaches the large charge of powder in the powder chamber, causing it to explode.

The projectile is three and one-half feet high and of course, thirteen inches in diameter. It weighs 1,100 pounds. In a groove passing around the projectile near its base is secured a copper ring, slightly larger than the projectile, which is forced into the rifling grooves by the compression slope in the gun. This is the sole means of engaging the projectile with the grooves.

The hardened point of the projectile is covered by a flat soft-metal cap, which holds the metal of the point together at the instant of impact, enabling it to enter the hardened armor. The projectile carries forty pounds of quick-burning powder in a chamber within it, and this powder is exploded when the projectile strikes, thus blowing it to pieces. The powder chamber is closed by a large screw-plug, which carries the primer in a hole at its centre. The primer has a



TURRET MOUNT OF 13-INCH GUN FROM FRONT.

The two lower recoil cylinders are in place on the sleeves, the upper ones being removed.

small plug, or hammer, which is held in a pocket by a brittle wire on which it is hung. As the projectile starts, the hammer breaks the wire and falls free to the bottom of the pocket. When the projectile strikes an object, the hammer is thrown forward against a percussion cap, and explodes the charge in the projectile.

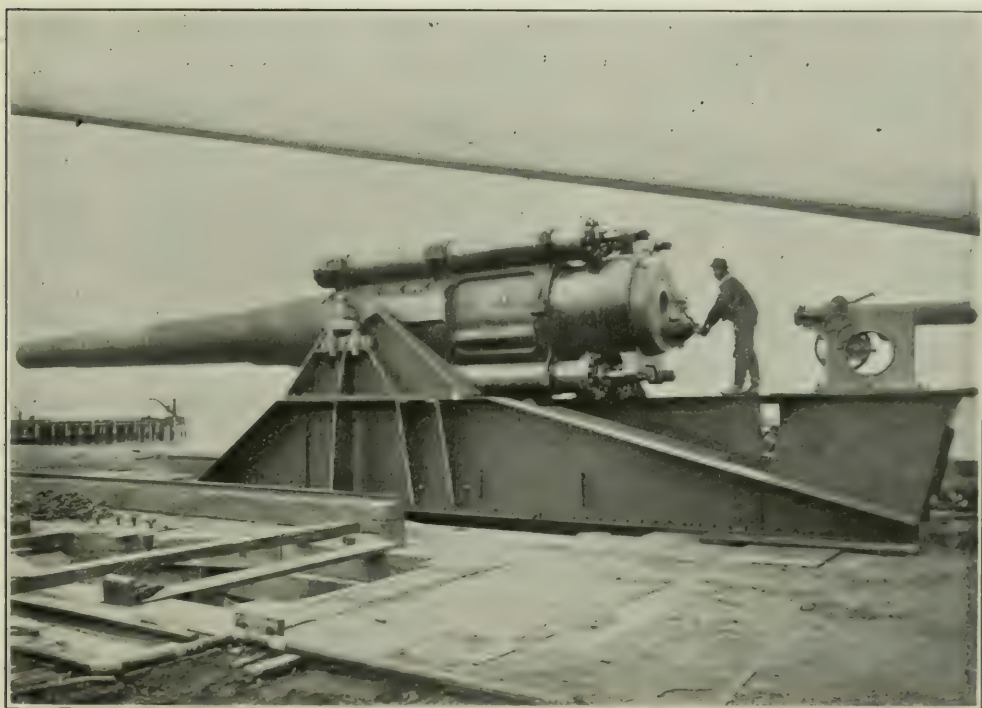
The gun is mounted in a "sleeve" pivoted in the "deck lugs" of the turret. A key, or bar, is secured in the gun, and fits a groove, or key-way, in the sleeve, to prevent the gun from turning in the sleeve, while allowing it to slide longitudinally. The gun recoils with a force of two hundred and twenty-five tons; yet this enormous strain is taken up, and the gun brought to rest, in the space of forty inches.

To take up the recoil four "recoil cylinders" are mounted in rings formed on the sleeve, and the rods of the pistons in the recoil cylinders are attached to a ring on the breech of the gun, so that the pistons go with the gun, and the recoil cylinders are fixed on the sleeve. Surrounding the piston rods within the recoil cylinders are twelve nests of heavy springs, which take up a large part of the recoil. The movement of the pistons is further retarded by a mixture of glycerine and water, which is allowed to escape past the pistons through grooves in the walls of the cylinders. At the limit of move-

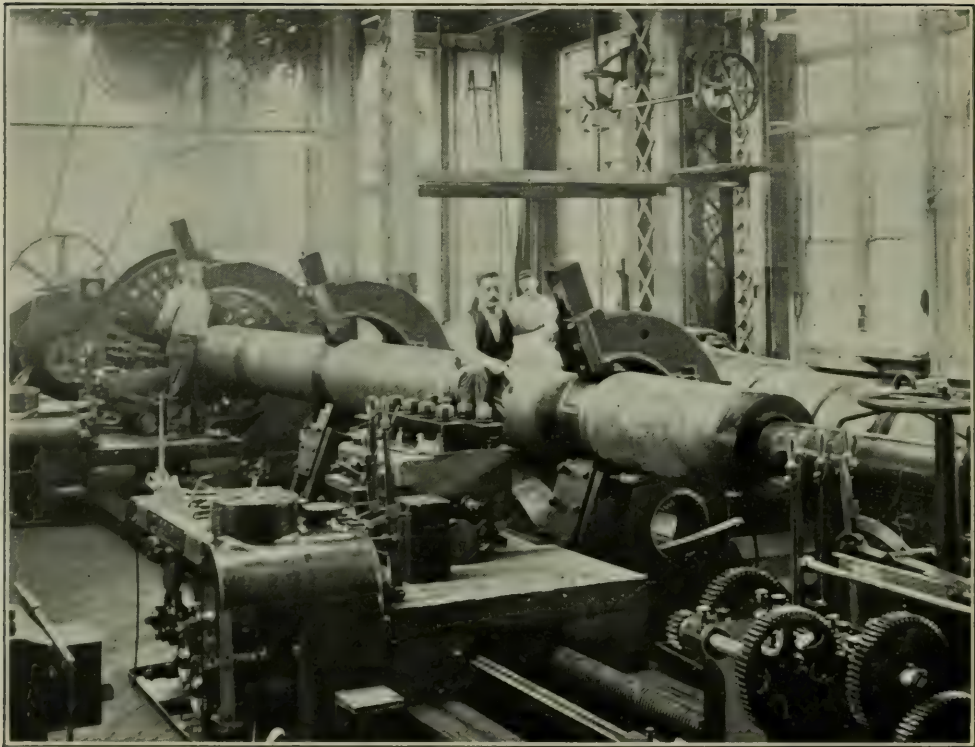
ment of the pistons the grooves end, and thus the pistons are stopped entirely. As the pistons recede on the recoil, they draw in water and glycerine behind them, and a valve prevents the outflow of this mixture, thus holding the springs from returning the gun to battery suddenly. By slowly opening the valve the latter operation is accomplished quietly.

The sleeve in which the gun slides is pivoted at the front on two trunnions, and is supported at the rear by a pair of links pivoted to the sleeve at their upper ends and, at their lower ends, to the sides of a nut travelling on an inclined screw. The screw is mounted in bearings, and is rotated from a hand-crank connected to it by sprocket-gearing to raise and lower the nut and, by this means, the gun. The lower end of the screw rests on a strong spring, to allow the screw to yield at the moment of recoil. Thus the elevation and depression of this ponderous gun are accomplished by hand, although a motor may be used if desired. At the rear of the gun mount is a rammer. Although this rammer is only about five feet long when contracted, its head may be extended fourteen feet by an ingenious arrangement of telescopic tubes. It may be operated by hand also.

The sighting is done through a telescope in the sighting hood, which is so connected by levers to the sleeve of the gun mount that it is always parallel with the gun. The gun captain in the sighting hood, by control of the motion of the turret and of the motor or men



13-INCH GUN WITH TURRET MOUNT, AT INDIAN HEAD PROVING GROUNDS.



BORING A TUBE FOR A 13-INCH GUN.

operating the elevating mechanism, sights the gun so that it points at the desired spot when the vessel is at the top of its roll ; and, at this moment of rest, he pulls the lanyard or presses the electric button which fires the gun.

An expert gunner cannot be made entirely by training. Under the regulations of the United States navy each member of a gun crew is made, at practice, to try his hand at firing ; and, from the records of the results, the gun captains are chosen. In one instance an apprentice boy of eighteen made so uniformly fine shots that he was promoted to the position of second gun captain. Some of the commissioned officers never become good marksmen.

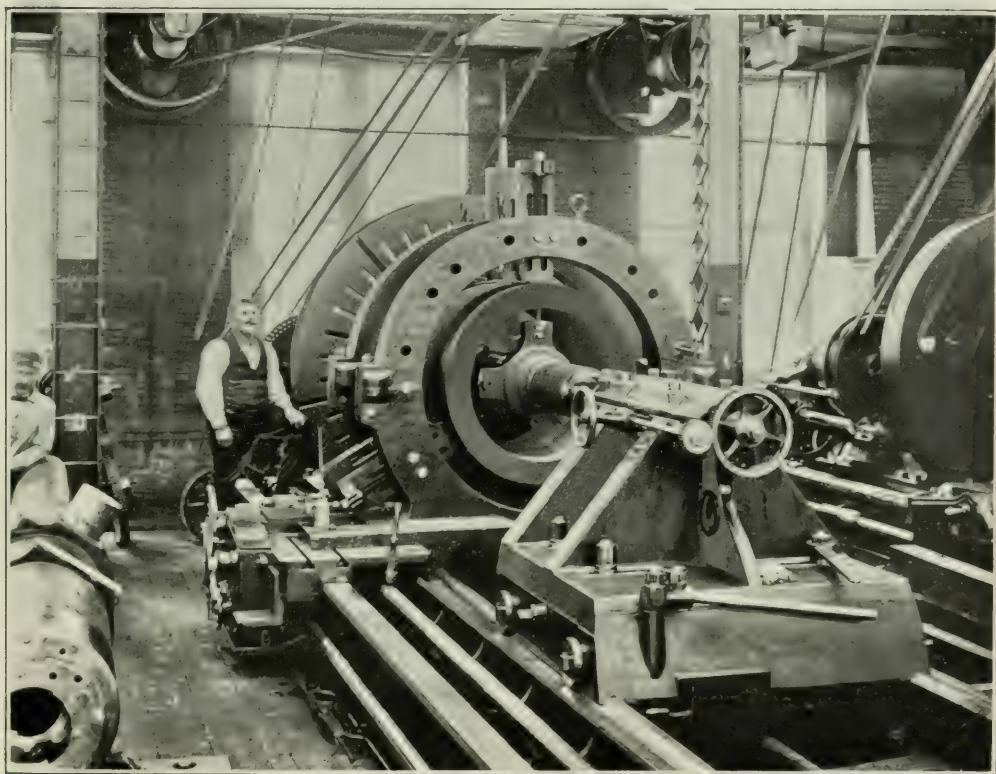
The principal parts of the gun are made from cast steel, tempered in oil, and carefully and repeatedly tested for strength and elasticity. The hoops and jackets are cast solid, and then a hole is bored through them to admit a mandrel, on which they are forged to elongate and enlarge them. The forging is tempered in oil and roughly finished, after which it goes to the naval gun factory at Washington, D. C.

In turning the partly built-up gun to prepare it for receiving the next layer of hoops, the gun is clamped to the face-plate of the head-stock spindle, and its muzzle is fitted with a plug in which is a conical hole that fits over the dead-centre on the tail-stock at the other end

of the guides. Rests, or goose-neck supports, are placed at intermediate points on the guides to take part of the weight of the gun. As the gun revolves, the tool with its carriage is moved slowly along the guides by a large screw. In turning the outer surface of one of the jacket hoops, the tool, in going once across from end to end, travels twelve miles, and occupies fifty-six hours in the operation.

In turning the inside of a hoop, the hoop is clamped in ring-like supports fastened on the tool-carriage, and the tool is secured in an arm on a mandrel, or bar, clamped to the head-spindle and supported on the dead-centre. As the tool cannot move along the guides, the hoop is moved slowly past the tool by causing the tool-carriage to move along the guides.

The outer surfaces of the tube, jacket, and hoops are turned in the same manner, but the bore and inner surface of the jacket are finished by the use of "boring-heads," or cylindrical heads having four cutters fastened in their forward edge. The head has four segments of wood fitted in grooves in its surface, and, when it is forced into the revolving tube or jacket by the boring bar on which it is carried, the wood is squeezed, holding the head in the bore so rigidly that it



TURNING THE INSIDE OF A HOOP.

The tool is carried by the revolving mandrel, and the hoop travels along on the tool carriage



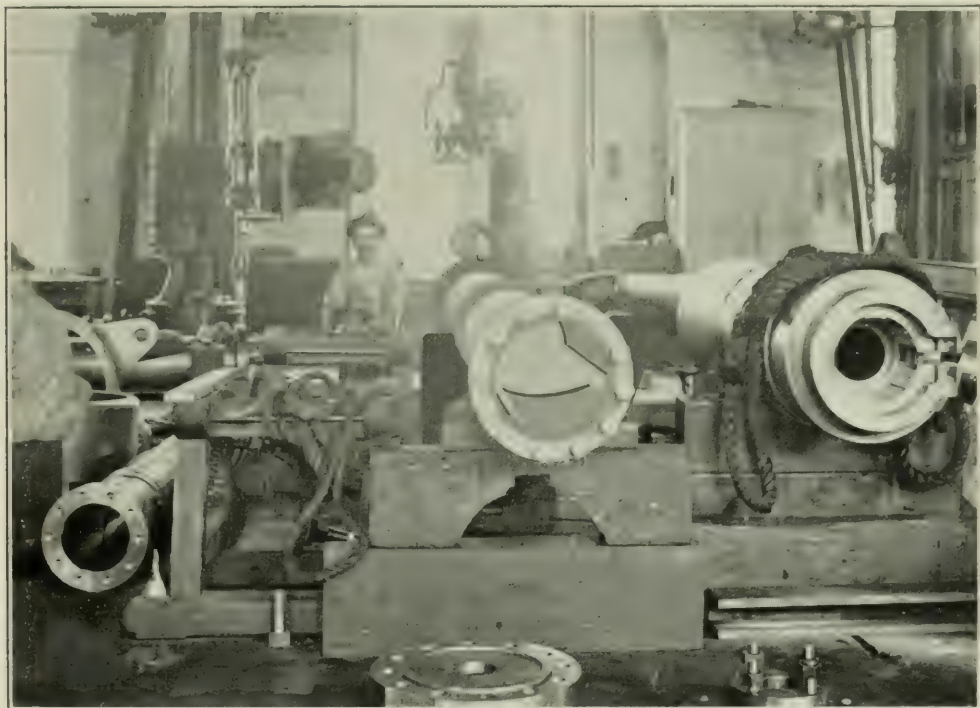
SHRINKING A JACKET.

The jacket, taken from the open furnace in the foreground, is descending over the tube.

is compelled to travel in a remarkably straight line while the cutters act, thus ensuring a perfect bore. So accurate is the work that the bore, although thirty-two and-a-half feet long, is not usually more than .002 of an inch out of a straight line.

In assembling the gun the tube is first bored and its outer surface finished; then the jacket is finished inside, and shrunk on the tube. The shrinking of a jacket is an event at the shops, and usually attracts

a good deal of attention. The jacket is heated to a temperature of 600° F. in a cylindrical furnace built in a large pit forty feet deep. Air, blown through a tubular furnace maintained at a white heat by burning sprayed crude oil, is forced through and around the jacket for twenty-nine hours. The burning blasts of oil make a roaring that interferes with conversation, and the entire operation is directed by signals and without one spoken word. The tube has previously been

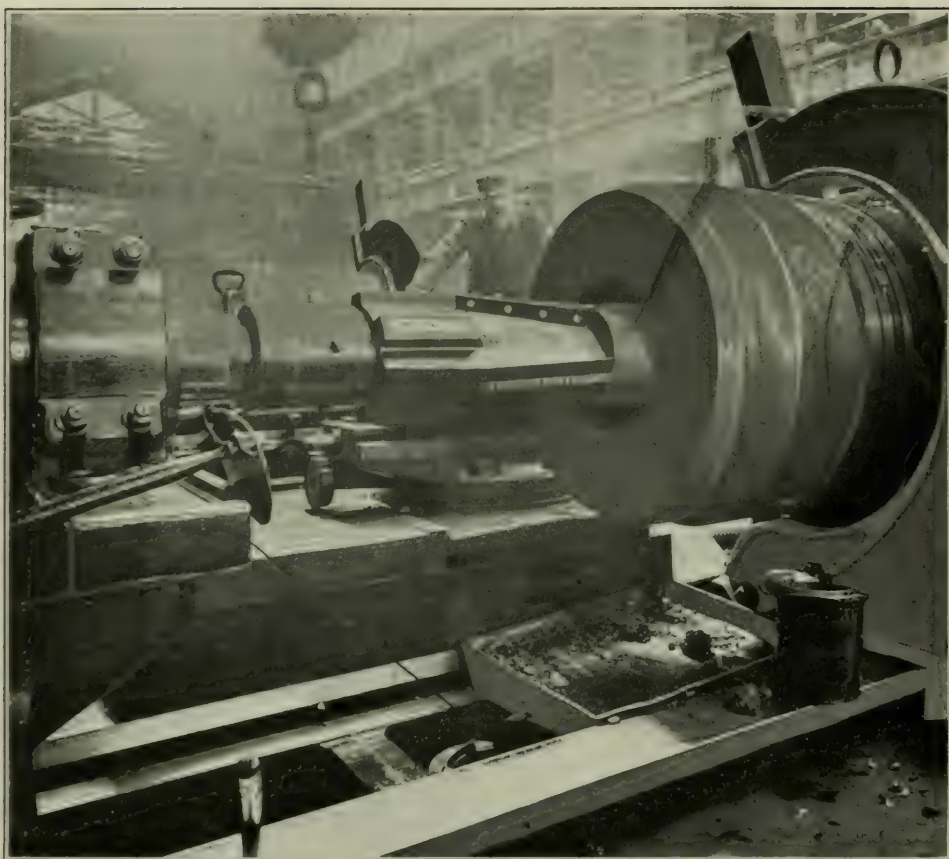


A RECOIL CYLINDER, SHOWING ITS GROOVES.

placed, muzzle-down, in the pit, and pipes are arranged to run water into the interior of the tube to keep it cool.

When all is ready, the foreman claps his hand and motions upward. A crane, travelling on overhead tracks, raises and carries away the iron cover of the jacket-heating furnace. A larger crane now comes, and, by chains hooked to trunnions on a ring clamped to the end of the jacket, the huge jacket, seventeen feet long and weighing 40,000 pounds, is raised from its casing as easily as you would draw a newspaper from its wrapper. To see if all parts of the jacket are evenly heated to the proper degree, the foreman rubs the surface, as it rises from the furnace, with sticks composed of alloys that melt at certain known temperatures.

The jacket is now swung to one side, and a star-shaped gauge is thrust through its bore to see if the heat has enlarged it sufficiently to go over the tube. The bore is found to be correct, and is cleaned out with canvas-covered swabs. The crane carries the jacket to the



CUTTING THE COMPRESSION SLOPE.

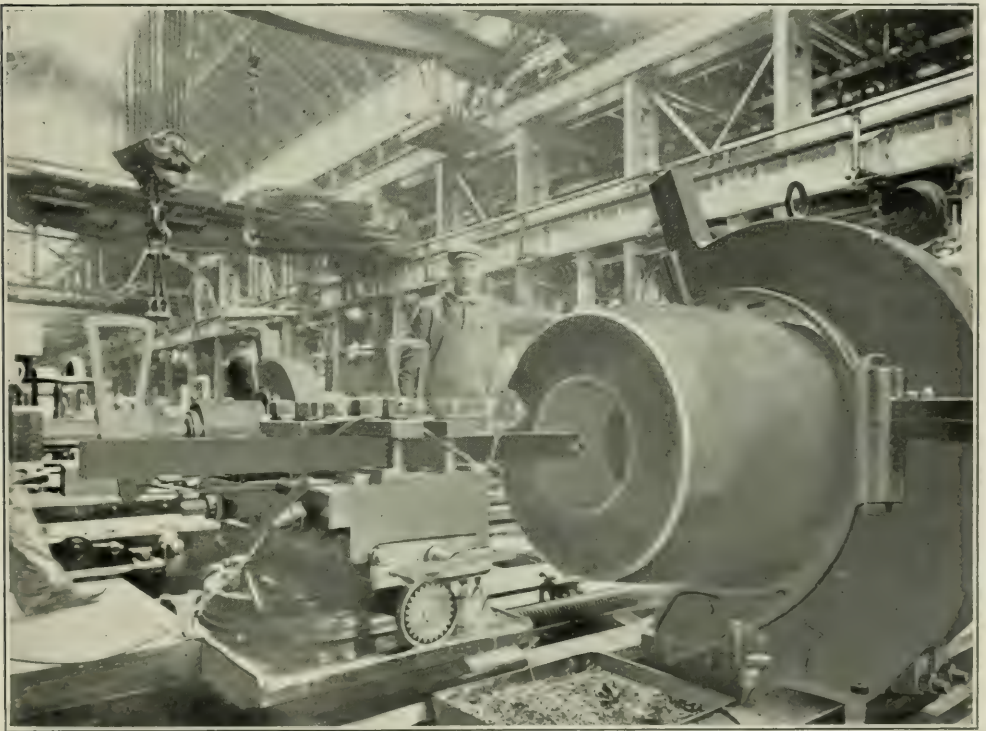
tube, over which the foreman, by motion to the crane man, carefully centres it. Four men protected with asbestos gloves now steady the jacket as it slowly descends on the tube. The crane which handles the jacket can easily carry off the finished gun, and yet it possesses such delicacy that the jacket is centred within one thirty-second of an inch and is lowered at the rate of but a foot in a minute.

After the jacket has cooled and shrunk on the tube, its outer surface is finished in the lathe, and the hoops are shrunk on. The outer surface of each part is finished after it is in place on the gun.

The compression slope, where the copper ring on the projectile enters the rifling grooves, is formed by feeding-in a reamer on a boring bar while the gun revolves. The reamer is a conical head, having four longitudinal cutters secured to ribs on the head. A larger brass ring on the head bears in the screw-box (which is not yet provided with its screw), and a smaller brass ring bears in the, as yet, smooth bore of the gun. The cutters, acting on the shoulder between the bore of the gun and the powder chamber, cut out the revolving gun, until a gradual slope connects these parts.

The next operation is the cutting of the screw-thread in the screw-box. The gun is, as before, revolved by the lathe, and a tool (whose point is the shape of the space between two threads of the screw), is clamped in the carriage of the lathe, and the carriage is moved forward by its screw about one and one-half inches for every turn of the gun on its axis. This motion, causing the point of the tool to trace a spiral in the screw-box, forms the thread. The six blank spaces in the screw-box are cut out by a tool that reciprocates longitudinally, the gun being slowly turned step-by-step between the movements of the tool.

In the rifling lathe, the gun is blocked up in line with the rifling bar, and a rifling head is attached to the latter. The rifling head is cylindrical and fits the bore accurately. It carries four cutters of the shape of the rifling grooves. The rifling bar has a groove in its surface which has just the twist desired for the rifling grooves, and a stationary pin, which engages the groove in the bar, causes it and the head to turn in the proper manner to form the rifling. When four grooves are thus finished, the rifling head is turned one fifty-second of a turn, and four new grooves are cut. The keyway in the top of the gun is cut when the rifling is being done, by a small milling machine mounted bodily on top of the gun. In this machine a horizontally revolving milling cutter is fed by a screw to cut the key-way.



CUTTING THE SCREW IN THE SCREW-BOX.

The breech mechanism, which is made in a separate shop, is attached while the gun, carefully greased, lies out of doors. To avoid taking the gun into another shop, a little knock-down house is hooked together around the breech while the mechanic, by electrically-driven tools, attaches the breech mechanism.

The finished gun is placed in the sleeve of its mount, and all the parts of the mount are put in place, or else an equivalent weight is attached. The whole mass is now raised, and placed on steel wedges supporting the large lugs on the sides of the sleeve from which the trunnions are to be formed. These lugs are made sufficiently large to allow the trunnions to be so located as to perfectly balance the gun. If the gun is accurately balanced, the power necessary to elevate and depress it is comparatively slight. The wedges are tried back and forth until, when finally placed, the gun muzzle can be raised and lowered by the hand of a woman. The officer in charge can calculate the position of the trunnions within one-tenth of an inch. Marks are now made to locate the centres of the trunnions.

The United States navy department has twenty-eight of these thirteen-inch guns. The battle-ships *Indiana*, *Massachusetts*, and *Oregon* have each been furnished with them, and the *Kearsarge*, *Kentucky*, *Alabama*, and *Wisconsin* will each have four.

It is difficult to appreciate the power, and at the same time the delicacy, of these great fighting machines. At the muzzle the immense projectile has been forced through twenty-seven inches of Harveyized steel. At two thousand yards the penetration is twenty-two-and-one-half inches. The extreme range is thirteen miles. The projectile leaves the gun with a velocity of 2,100 feet per second, or 1,400 miles per hour. A shot can be fired every one and one-half minutes for a period of several hours. The force imparted to the projectile, if properly applied, would lift a battle-ship bodily three feet, and yet this great machine, weighing 145,000 pounds, is as accurate as a high grade watch.

THE DEVELOPMENT OF THE RAILWAYS OF CANADA.

By Walter E. Weyl.

MUCH of the acrimonious discussion over the question of State versus private ownership of railroads might be averted, did the advocates of either system recognize the limitations of their own arguments. It is characteristic of such dialecticians that they apply the results of one nation's experience to the problems confronting another, without considering the modified circumstances by which such experience is conditioned.

It is especially necessary to take this national equation into account in comparing the railways of Canada with those of the United States. The experience of these nations presents a series of parallels and contrasts directly traceable to the similar, or to the diverse, conditions existing in the two countries. Both in Canada and in the United States railways have grown more rapidly than population ; in both countries they have often preceded roads, and even settlement itself ; in both the lines have been cheaply and rapidly constructed, and have been extended into the most sparsely settled districts. In Canada as well as in the United States the main arteries of railroad communication run east and west ; in both countries the policy of private construction, ownership, and management has prevailed ; and generosity towards the railways, as exemplified by large grants of land or money, has been common to the governments of both. The contrasts in the policy adopted on either side of the boundary line are equally striking, if less important ; but the underlying similarity in the railroad history of the two countries can be shown to have its cause in the like economic conditions and tendencies prevailing.

The English, on the whole, have favored a policy of private ownership of home, and of governmental ownership of colonial, railways, but to this rule the case of Canada furnishes an exception. While the railways of India, of Australia, of the Cape, of Natal, etc., have been largely constructed or managed by government, the development of the railways of Canada were at first left to individual initiative. This *laissez-faire* policy of the government may be attributed in part to the economic doctrine then supreme in England, but it was no less due to the discouraging outlook for railroad enterprises in Canada. At the beginning of the railway era the total population of British North America scarcely exceeded half a million, and these were mainly clustered in what are now the provinces of Quebec and Ontario and within easy reach of the great lakes and the

St. Lawrence. Separated from the unknown territories of the west and from the maritime provinces of the east, even these tracts were too thinly peopled to invite large outlays for railroads, particularly in view of the exceptional advantages presented by cheap inland navigation.

These adverse conditions were as potent in checking private enterprise, however, as in discouraging governmental activity, and the result was that, for a considerable period, the development of Canadian railways was exceedingly slow. As late as 1845 an insignificant sixteen-mile road from La Prairie to Quebec was the only railway within British America. During the fifties, however, the construction of the Grand Trunk, the Great Western, the Northern, and other lines was begun, and the mileage quickly grew from 71, in 1850, to 2,087 in 1860. The increasing population, the expansion of the settled area, the opening up of new lands to agriculture, and the steady increase in wealth and industry were causes, as well as effects, of improved means of land transportation, and, after the consolidation in 1867, economic, political, and military considerations united to increase the extent of the railroad net. The Grand Trunk continued to grow in length, the Intercolonial and Prince Edward Island railways were constructed, the Canadian Pacific was pushed forward to a speedy completion, and branch lines were everywhere thrust out to the margin of settlement. The length of the railways increased from 2,150 miles, in 1866, to 5,157, in 1876; to 10,697, in 1886; and to 16,270, in 1896, the length of road in operation during the year 1897 amounting to 16,550 miles. The present extent of Canadian railways is thus only one-eleventh of that of American lines, but, with an approximately equal area, Canada's population bears a still smaller proportion to that of the United States; and, despite the fact that the dominion contains less than five million inhabitants, there are but seven countries in the world that can boast of a railway mileage greater than that of Canada.

This rapid development is to be attributed, in no small degree, to the financial aid of the State. Grants of land and money have been made by the dominion, by the several provincial governments, and by municipalities, and of a total paid-up capital of \$920,000,000 no less than \$197,000,000, or 21.4 per cent., was thus contributed, the average subsidy amounting to about \$12,000 a mile.

Of the total amount thus granted, the dominion contributed more than three-fourths, or about 76 per cent., the municipalities 8 per cent., and the provincial governments 16 per cent. Among these latter the government of Quebec has been unusually lavish, furnishing almost half of the total provincial contributions, and, with a railway mileage

not half so great as that of Ontario, more than doubling the donation of that province.

This policy of fostering the growth of railways by government subsidies has been subjected in Canada to considerable adverse criticism. It has been argued that the taxpayers have made immense sacrifices ; that the lavish donations of the State have resulted either in the destruction of national wealth, or in its conversion to the uses of private persons ; that this generosity has had a demoralizing effect upon the railways themselves ; and that it has tempted them to convert Ottawa into one great lobby. These views, however, are far too pessimistic. A government subsidy should always be in the nature of a sacrifice. The policy has its *raison d'être* in the desire to combine the advantages of private and of State construction of railways, to encourage the growth of useful, but unprofitable, lines, without sacrificing the impetus derived from individual initiative. In populous and highly-developed countries, such as France, this assistance of the State has been principally required for the construction of local lines (*réseau nouveau*), but in Canada the government subsidies have aided the extension of the net by the construction of long through lines.

The favorite child of the dominion has been the Canadian Pacific. That company has received a grant of \$15,000,000 in cash, 25,000,000 acres of land, and about 640 miles of completed track, the last item, including preliminary surveys, costing the government some \$33,000,000. The advantages accruing to the dominion from these sacrifices have been very great. Canada, east of Lake Superior, has always had the advantage of water connection with the Atlantic ocean from the end of March until the end of November, but west of the lakes communication was almost non-existent. Between Port Arthur and Winnipeg there was only "the old canoe route," which, moreover, could not be used to transport immigrants, and there was no connection at all with British Columbia. Half a century ago the necessity of an inter-oceanic line had already been felt, and in an open letter, in 1847, Major Carmichael Smith wrote as follows : " This great national highway from the Atlantic to the Pacific is the great link which is required to unite in one powerful chain the whole English race." But, while the United States rapidly completed several of these "great links," the Canadians, with their smaller population, lagged behind. After the consolidation, however, an extension of the railroads towards the west became a necessity. At this time there were no railroads in Manitoba, in British Columbia, or in the northwest, and even ten years later the conditions were hardly changed. Without the iron road the consolidated was a union in name only,

and therefore in 1871 the government commenced the extensive survey of the territory through which the Canadian Pacific was destined to pass. In 1877 the dominion began the construction, but by 1881 it was decided to hand the enterprise over to a private company, on the condition that the road should be finished by 1891. This condition was more than fulfilled. By 1886 the railroad was completed, with a mileage of 4,533, and since then it has rapidly grown by new construction and by buying, leasing, or operating other roads, until at present it represents the consolidation of twenty-one Canadian lines, and owns or operates about 7,251 miles, about a seventh of which is situated within the United States.

The Canadian Pacific is neither the first or the only railway in Canada which has grown by the absorption of other lines. Amalgamation has taken place much the same as in England, France, and the United States. Of the 144 railway companies in Canada in 1896 (including eight electric railways and bridge and tunnel companies) 21 have been amalgamated into the Canadian Pacific system and 25 into the Grand Trunk system; the remainder are more or less combined. The public has frequently recommenced the Sisyphean labor of forcing railroads to compete. The Ontario & Quebec was constructed at great expense to compete with the Grand Trunk, and the province of Manitoba spent fully \$600,000 to make the Northern Pacific enter into a competition with its northern rival. But war has ended in peace, competition has been short-lived, and the truce that invariably ensued led to an agreement of some sort, if not to actual consolidation.

The Grand Trunk is a notable example of this process of amalgamation. Lying within the fertile peninsula bounded by Georgian bay and Lakes Huron, Erie, and Ontario, it has successfully acquired, by lease or purchase, property after property, until its length has increased to 4,186 miles. It is becoming increasingly an American line, obtaining foothold in Michigan, Indiana, Illinois, Maine, Vermont, etc., and having recently obtained complete control of the ill-starred Vermont Central.

What the Canadian Pacific is to the western provinces and the Grand Trunk to Quebec and Ontario the government railways are to the maritime provinces, New Brunswick, Nova Scotia, and Prince Edward's Island. As political and military exigencies dictated its futile policy of building the Canadian Pacific, so the government ownership of the Intercolonial and Prince Edward's Island railways was determined by similar conditions. As early as 1832 it had been proposed to build a line connecting Quebec with the sea-coast towns of Nova Scotia and New Brunswick, and, after a survey in 1835-37, the oppor-

tunity of constructing this important line seemed to have come. But the course of the proposed railway would have led directly across territory then claimed by, and subsequently awarded to, the United States, and the railroad, as finally constructed in 1876, followed a circuitous route, in order to skirt the northern boundary of Maine.

In consequence of this wide detour, which was justified on military grounds, the Intercolonial railway is a needlessly long and uselessly expensive line. Its present length is 1,189 miles, including a short line (Windsor Branch), which is operated, but not owned, by the government. While the government has already expended more than sixty millions of dollars upon this unfortunate railroad, the road, since 1872, has been operated at an annual loss ranging from \$26,000 to \$954,000. The financial failure of the Prince Edward's Island Railway, the only remaining government railroad enterprise, has been perhaps even more disastrous, this road having been operated at a deficit from the beginning. These results, however, may not be used as arguments either for or against governmental management of railroads. Though financially a failure, the State railways of Canada have been in many ways a success. They have helped to join the eastern provinces in a strong political union, to create a traffic with Quebec and Ontario, to foster a feeling of solidarity, and to be serviceable to the country in the deplorable event of an American or oriental war. The nation stepped into the breach where private capital hesitated, and the millions that have been spent have not necessarily been wasted.

The financial success of a railroad, or of a system of railroads, depends upon the relation that the excess of revenue over operating expenses bears to the total cost of the line. A railroad may be successful because its gross receipts are large, or because its working expenses are small, or because its capitalization is low, or through a combination of some or all of these circumstances. The net income of a railroad may be large, but where, as in the United Kingdom, the capitalization is very heavy, the net revenue per dollar of invested wealth is small.

In new and sparsely-settled countries, the railroads are usually capitalized at a low figure. In the United States the capitalization is considerably heavier in the east than in the less populous west, and the same relation obtains between western Europe and the more sparsely settled countries of the east. The capitalization of Canadian railways is \$52,000 a mile, which is less than that of United States roads (\$59,610) and considerably less than that of roads in many European States. The capital account per mile of railroad in England is about five times, in Scotland more than three times, in France

and Belgium more than twice, and in Germany, Switzerland, Holland, and Italy from once and a half to twice, as great as in the dominion of Canada. This low capitalization is due not only to the sparseness of the population, but to the comparative youth of the Canadian railways. The capital account of British railways increased from £24,630 in 1838 to more than £47,200 (\$235,000) in 1895, but this has been largely due, as in other countries, to the tendency of the railroads to branch out into industries other than that of transportation.

The chief cause of the low capitalization of Canadian railways is the obvious one of low cost of construction, but cost and capitalization are not quite identical. In Canada, as elsewhere, the capital account has been swelled to larger proportions by the facile expedient of stock-working. When the Manitoba & North Western went into receivership, it was bonded to from fifty to one hundred per cent. above its cost of construction. The second issue of Canadian Pacific bonds was made at 25 per cent., and a subsequent and still larger block was sold at 52. There is a natural tendency for the capital account of all corporations to approach, not the actual investment of capital, but the real value of franchise and other property; thus the inflation of railway property for the purpose of concealing profits, or from less laudable motives, has obscured the actual cost of constructing the railroads. In the absence of trustworthy statistics, however, we may still infer that the cost was not excessive. The right of way, which in thickly-settled districts is costly, and on which the English railways, according to a moderate estimate (that of Jeans), expended fully one-tenth of their total capital, was obtained in Canada cheaply, if not *gratis*. The vast sums often expended on palatial stations, on terminal facilities in great cities, in avoiding grade-crossings, etc., were not demanded by Canadian conditions. In the United Kingdom immense sums have been spent in promoting and combating parliamentary legislation, and drains have been made upon the resources of the railroads by all forms of legal and extra-legal extortion. On the other hand, many of the raw materials of construction have been dearer than in Europe, and the Canadians have only partially pursued the policy of substituting cheap alien for the dearer native labor.

A final cause of the low construction cost of Canadian railways is found in the character of the lines. In Canada, as in the United States, there has been in the character of construction a wise adaptation of means to ends, and cheap, light, single-track lines have been built, instead of the heavier and more durable track, in more populous districts. As traffic increased, the light structures have been perfected and supplemented; steel has taken the place of iron, and even of wooden, rails, and the permanent way and rolling stock have

been generally improved. But the railways of Canada are still far more lightly constructed than those of the United Kingdom, or France, or Belgium, owing to the smaller amount of traffic.

The bulk of this traffic is freight, the receipts from this source amounting to 64 per cent. of the total income in 1897, while only 9.4 per cent. were derived from mail, express, and miscellaneous sources, and but 26.6 per cent. from the passenger business. The preponderance of the freight traffic, achieved in spite of water competition, is due to the sparse population and the large area, distance acting considerably less as a deterrent to freight transmission than to travel. The passenger traffic of Canada has grown very slowly. While the tonnage moved, per head of population, increased 194 per cent. (from 1.60 to 4.73 tons) from 1876 to 1896, the number of travellers increased only 106 per cent. (1.40 to 2.88) during the same period. While the Canadian thus averages only 2.9 trips a year, the average in the United States is 8.2, in France 9.1, in Germany 10.4, in Belgium 14.7, in the United Kingdom 24.4 (excluding season tickets), and an almost equal number in the New England States. If the length of the trip is taken into account, the statistics of travel are not so unfavorable to Canada, since in all rural, and particularly in thinly-settled, districts (Russia, Norway, Hungary, Roumania, and the western States) the average distance covered by a traveller is generally great. Like the English railways, those of Canada do not as a rule give statistics of passenger-mileage, but a rough calculation gives the average trip as about forty miles. On the Canadian Pacific each traveller is carried 46.5 miles, and the rate per mile is 2.74 cents. If this fare obtained throughout the whole of Canada, the average distance travelled would not be far from 33 miles, but, despite the high fares in Manitoba and the northwest, where four and five cents a mile are not unusual, the average receipts per passenger-mile are probably less. On the assumption of 40 miles per passenger, the average yearly travel *per capita* equals only 116 miles in Canada, as compared with 153 in Germany, 170 in France, 208 in the United States, and about 250 miles (est.) in the British Isles. With three-fourths of Belgium's population, three hundred times its area, and six times its railway mileage, Canada carries but fifteen million (14,810,407) passengers compared to little Belgium's hundred million,—a difference only partially compensated for by the smaller *parcours* (about 13 miles) on the Belgian railroads.

Since 1885 the passenger traffic has increased more slowly than the railway mileage, and from 1890 to 1895 it has remained almost at a standstill, but an increase of 15.6 per cent. in the traffic from 1895 to 1897 indicates a coming revival in the passenger business.

The freight traffic has also recovered from the ill effects of the business depression of recent years; but, despite the recent increase in traffic, the total earnings per mile of road have steadily declined. In 1875 the receipts per mile of road were \$4,033; in 1880 they had sunk to \$3,418; in 1885, to \$3,175; in 1895, to less than \$3,000. This decline, which may be paralleled elsewhere, is due partly to the construction of new and temporarily unremunerative railways, and partly to the great decline in freight charges, which has been so striking a feature of American railroad history. The receipts per ton-mile on the Canadian Pacific declined from 1.50 to 1.17 cents from 1889 to 1896, and numerous other instances of cheapened transportation might be cited.

The result of comparatively low rates and sparse population has been diminished receipts per mile, the statistics for Canadian railways showing but \$3,107 in 1896 compared to about \$7,000 in the United States, \$11,000 in France and Germany, \$12,000 in Belgium, and almost \$24,000 in England and Wales.

Fortunately the operating expenses have declined still more rapidly. During the twenty years ending with 1895, the operating expenses declined from \$3,268 to \$2,049, and, while the working expenses formed 82 per cent. of the total revenue in 1876, the proportion had sunk to 69 per cent. in 1896. Despite this decline in the coefficient of exploitation, however, the net earnings, \$15,500,000, furnish but a very moderate return, 1.72 per cent., upon the total paid-up capital, including the government subsidies.

The Canadian railways have passed through a storm and-stress period that has been accentuated and aggravated during the last few years. The slowly-returning prosperity of both the United States and Canada promises to aid the railroads of Canada, and railroad securities have risen, with increase in railroad profits. The suspicious decline in operating expenses within the last few years has occasioned a slight scepticism as to the actual extent of the increasing prosperity of the railroads, and pessimistic views are held in London and elsewhere concerning the ability of such roads as the Grand Trunk to weather future storms. It seems probable, however, that the future progress of the Canadian railroads will be continuous, if not rapid. The bright promises of twenty years ago have not been realized; population has increased slowly, and the great country to the south has robbed Canada of its immigrants. But the Canadians have built for the future, and the development of Manitoba and the west and the increase of manufacturing in Quebec and Ontario, coupled with a conservative railroad policy, doubtless will improve the railway conditions in Canada.

EFFECTIVE SYSTEMS OF FINDING AND KEEP- ING SHOP COSTS.

By Henry Roland.

THE METHODS OF A SUCCESSFUL MACHINE-TOOL WORKS.

MACHINE tools occupy a place of so large importance in modern industrial enterprise, and their manufacture involves in itself so many diverse, but closely dependent, operations, that the exposition of a system which has proved efficient in recording the cost of machine-tool building possesses peculiar interest.

Bement, Miles & Co., of Philadelphia, Pa., U. S. A., to whose courtesy is due the information embodied in this paper, are widely known as builders of an excellent line of medium and heavy tools.

Their establishment is complete within itself, making its own castings and forgings, and the shop accounts treat the establishment as a unit, there being no separation of the foundry and forge shop from the machine shop or selling department.

The subject of cost-keeping has been a matter of vital interest as well as careful study to the management, and especially to Mr. Clarence Bement, and has been approached with full recognition of the great difficulties which lie in the way of really accurate cost determinations.

The result of this exhaustive knowledge of cost-keeping conditions has been the introduction of a system intended to recognize, so far as possible, the accurate costs of all details of machine-tool building. Any widely inclusive system must of necessity involve a great number of divided accounts, and a vast amount of clerical labor, some of which may be avoided by the lump-sum methods of less minutely subdivided cost-keeping systems.

The Bement cost-system includes every expense item which can possibly be classed under that head. Interest on realty, interest on machinery, tool-depreciation on a basis of final extinguishment of values, and, in short, all those items of expense which, as has been previously pointed out, are disputed by some manufacturers, are included in the Bement and Miles expense account. Small tools, foundry flasks, patterns, jigs, templets, and special tools are divided in the accounts, a part of each going to assets and a part to expense.

No detail of these percentages of divided accounts need be given, as the ratio of division is an assumption at best, varying with the judgment of each manager. For instance, in the important item of wooden patterns for foundry use, accuracy demands an accounting

with each set of patterns made. A set of patterns for a popular, quick-selling, regular tool is in almost constant use, and is a valuable money-earning asset, while the patterns for a specialized modification of the same tool, used but seldom, and having to go to the pattern shop for extensive repairs each time they are used, as a result of long idleness in the pattern storage rooms, are an expense only, both for first cost and idle storage. And the case is the same with all special tools and fixtures, the values depending solely upon frequency of use, so that anything in a machine shop may fall into the asset or expense account. If used continuously in productive operations, any tool whatever becomes a producer and a valuable asset, laid upon a shelf until required for its infrequent handling, any tool or fixture is an expense instead of an asset, and should be charged into the special expense account made against the machine for which it was first built. But again, suppose a special tool is built for a new special machine under construction, and is charged to the special expense account of that machine and paid for in the selling price. Suppose, further, that this special machine unexpectedly finds large sale, and so becomes standard, and hence in regular manufacture; then all the special tools and fixtures made for it and charged as expense to the first production and paid for become valuable money-earning assets, which do not appear in the inventory, their inventory value having been extinguished by original charge to the special machine expense. Problems of this sort constantly appear in factory cost-keeping, making absolute accuracy impossible; indeed, they make any attempt in the direction of minutely detailed correctness a mere source of clerical confusion. Patterns for foundry use form, perhaps, the most obvious stumbling-block in this direction. They are very costly and very bulky, and demand the utmost care in storage to make them keep their shape and so not utterly destroy themselves through mere idleness. At the Bement works to-day one large building is filled with patterns by far the larger portion of which can hardly be said to be in regular use; and in the present busy condition of the shops this building could very profitably be used for other purposes, and made a productive area, instead of an unproductive harborage for idleness. Who can tell with any degree of accuracy what the expense totals of this pattern storage building really are?

It is such cases as these which apparently justify the lump-sum expense-estimating methods adopted in some thoroughly successful cost-keeping systems, and which deprive of value the detailed records of the percentages of divided accounts. All the conditions are special in each instance, and only the general information that this or that account is divided between assets and expense, or is credited wholly to

one or charged wholly to the other account, can be of any value to the manufacturers at large. On this point it is enough to say that the Bement and Miles theory of manufacturing expense formation is founded on the obviously correct assumption that every expenditure, of any nature whatever, is an indebtedness which must be carried on the books until cancelled by actual payment in cash. There is no juggling with realty under the fiction of "original investment," no carrying of antiquated tools at full price on the inventory because they are constantly repaired and kept up to their original efficiency, and, in short, no diminishing of the expense account by any fiction whatever. Anything which cost money is indebted for that cost, until it is paid for in cash.

Labor is paid in the Bement and Miles shops mainly at piece-rates, and the piece-rates are subject to adjustment. There is considerable day-pay work, also. Workmen's time is kept by a time-keeper at the single entrance and exit, who gives an individual numbered brass check to each hand as he enters the works, and takes it up again from the workman as he leaves the shop. The weekly pay-roll is made up from the time-keeper's time-account as evidenced by the giving out and return of the workmen's individual brass checks. This weekly pay is in full for the day-pay hands, and at a fixed day-rate for the piece-hands, whose piece-rate earnings are audited once in two weeks, the worker being paid the difference between his total earning and the weekly payments he has received.

Work goes into the shop on an office order to the drawing-room. The drawing-room order-card—size, $2\frac{1}{2}$ inches $\times$ $3\frac{1}{4}$ inches—is printed on only one side, and is reproduced below.

A.

Ordered, _____ Del. _____
 Symbol, _____ Finished, _____
 Gen. dw'g, _____
 Details, _____
 Forgings, _____
 Alter'ns, _____
 Bolt Card, _____
 Diagram, _____

This order insures the transfer of the needful drawings and specifications to the heads of departments.

The day-worker's time is kept by the workmen on individual time cards ruled for seven days' work, as per sample given below. The time given on these cards is checked by the time-keeper from his brass-check record, discrepancies between the two being not un-

known. The size of the day-rate worker's card is 3½ inches × 5¾ inches, printed on one side only. In the example given below the first two lines are filled out.

No. 100. Date, April 6th, 1898.

TICKET No.	HOURS.	DESCRIPTION OF WORK. SYMBOL.	MACHINE USED.		
3058	10¼	2 P Q 220-221	✓		

 Enter your day's work on lines above, and drop slip in Time Box BEFORE LEAVING each night. No time allowed except on slips in Time Box.

The piece-worker's contract card has spaces for forty-six separate entries. These cards bear consecutive numbers, and are torn from a duplicate-stub book. As will be seen, each of these piece-rate cards forms a complete document by itself. The size is 3 inches × 5 inches, printed on both sides, as shown on opposite page.

The screw-room card is spaced for seven days' entries.

The screw-room forms a distinct feature in the economy of the Bement and Miles establishment. It has always been the policy of these shops to use young labor in the form of a full complement of apprentices. As a consequence, there are many applicants for apprenticeship who are under the desired age of seventeen years. From these juniors the screw-room force is recruited. A boy of promising appearance is told that he is too young to enter as an apprentice, but that he can go into the screw-room, and, if his conduct there is satisfactory, he will be made an apprentice as soon as he is old enough. The screw-room machine equipment embraces turret-machines and the usual screw and stud finishing machines, and the boy's year or so of probation in the screw-room is advantageous both to himself and to the shop. Apprentices receive careful attention in these shops, and very quickly become useful.

The screw-room time card is printed on one side only, and is reproduced opposite. Its size is 3¾ inches × 5½ inches.

gress at these shops. The job order goes to the heads of departments on the card order given in blank below. The card is $4\frac{1}{8}$ inches $\times$ $5\frac{1}{2}$ inches in size, and is printed on one side only.

BEMENT, MILES & CO.

Job.....	189
For.....	.....
.....	
.....	
Shipped.....	189

Piece-rates at the Bement and Miles shops are fixed by a piece-rate clerk, by consultation and from previous records.

Hour-rates are fixed for all machine tools used in job work, but no account is taken of tools used on shop, day, and contract work.

The total labor payments are used as a divisor of the total expense for the last year, to obtain the expense percentage to be added in order to arrive at the total cost for the current year.

The workmen's cards or time tickets, previously given, are merely blotter charges, from which day-book, journal, and ledger entries are duly made, separate accounts being kept with all machines in regular manufacture.

In point of detail and comparison and cross-checking the Bement and Miles cost-keeping system is very full, and demands a corresponding amount of clerical labor. As has been pointed out, there is absolutely no limit to the subdivision of cost-keeping accounts. Between the single solitary cost-card which contains the whole of the Strieby and Foote cost-keeping books, as detailed in the previous paper of this series, and the elaborate set of books kept by Bement and Miles there is certainly a very great and striking difference. But there is an equally great and striking difference in the conditions of manufacture in the two establishments. In the Strieby and Foote drop-forging shops the entire round of operations does not vary much from those required to produce only the simplest pieces made in the Bement and Miles smithy. Machine-tool manufacture is perhaps the most complicated of metal-working industries classed as a single vocation. In reality machine-tool building embraces invention of a high order, founding, smithing, machine-finishing in all its many branches, painting, preparing for shipment, and all the mercantile details of the selling department. Hence the possibility of Strieby and Foote's single piece of printing to hold all accounts, and the necessity of the elaborate system of bookkeeping by which the costs are found and kept in an establishment like that of Bement, Miles & Co.

MILLING THE GOLD ORES OF THE WITWATERSRAND.

By H. H. Webb and Pope Yeatman.

THE mill, in Witwatersrand practice, is but the first stage in the general metallurgical process, preparing the ore not only for its own treatment, amalgamation, but for the second step, the cyanide process; for it must be remembered that, but for the cyanide process, a very small percentage of the mines on the Rand would pay, and that the industry as a whole owes its salvation to this method of gold-extraction.

There are no very difficult problems in the treatment of the Rand ores. The gold is found in a conglomerate consisting of quartz pebbles cemented together by a siliceous filling, which near the surface is impregnated with oxide of iron, and, below the zone of oxidation, with iron pyrites. The absence of base metals renders the treatment by amalgamation, supplemented by cyanide, extremely simple from a metallurgical point of view, and to this fact is largely due the wonderful development of the cyanide process on the Witwatersrand.

To examine the question of milling alone without considering the subsequent cyaniding of the tailings would produce a false impression, conveying the idea that the stamp practice on the Rand, in percentage of gold extracted, compares unfavorably with that of California or other places. The object is to get the greatest extraction at the least cost, by combining the two processes, the tendency being towards a high crushing capacity rather than a high extraction by amalgamation at the expense of crushing, relying on amalgamation for a fair percentage of the catch, and increasing the extraction by the subsequent cyanide treatment. In other words, the tendency is to make the stamp mill more of a pulverising machine than an amalgamator.

While it is usual on the Rand to amalgamate in the batteries, less attention is paid to the practice than is common elsewhere. The easily amalgamated gold is caught on the outside plates, and the more refractory portion is treated by cyanide. Coarser crushing would be the rule, were it not necessary, in order to secure the best results in cyanide treatment, to have the ore crushed fine. If the crushing is too coarse, very fine gold becomes locked up in particles of quartz or pyrites, and the cyanide solution has but little opportunity to act

upon it. It is not to be understood from the above that amalgamation is neglected, but only that higher yield in the mill is sacrificed that a greater profit may be made through a greater output, reduced costs, and possibly greater combined yields. The good manager endeavors to so combine the two processes as to get the greatest extraction at the least cost.

The first mill, a battery of 5 stamps, at which any of the banket of the Witwatersrand was crushed, was erected in 1885 by Messrs. H. W. & Fred Struben, about ten miles from the place where Johannesburg now stands, for the purpose of working quartz reefs. The following year several samples of conglomerate were crushed, the highest yield being 8 dwts. per ton. Mr. H. W. Struben, in an interesting letter dated January 17, 1893, says: "We milled conglomerates from Vogelstruisfontein, both for ourselves and for others, at our private mill, long before any one else had a mill."*

In April, 1887, the Jubilee Company completed the erection of a three-stamp battery. These were probably the first stamps operated on the Witwatersrand itself. The *Diggers News*, speaking of the event at that time, said: "The machine is kept going during the whole twenty-four hours, and the manager calculates on being able to get through five tons of ground per day, and to have a steady monthly return." "Room is left for another five stamps to be added to the battery."

In May of the same year the Wemmer Company completed the erection of five stamps of their ten-stamp mill; and in August the Witwatersrand (Knights) Company had in place 50 stamps of their 100 head, each weighing 750 pounds.

The State mining engineer's report for 1896 gives the number of stamps for that year on the Witwatersrand at 4,291, and the number of tons crushed at 3,980,682, the yield being £5,346,527, or an average of 26.36 shillings per ton. Including treatment by cyanide and chlorination, the total yield was £7,781,845, or 38.95 shillings per ton, and the average duty per stamp per twenty-four hours 4,392 tons. Eight hundred and sixty stamps have been dropped since 1896.

There are few mills of less than 60 stamps on the Rand to-day and those of 100 and more are in the majority. The tendency of the newer mills, for large claim area, is toward 200 stamps, those of the Crown Deep, Rose Deep, Nourse Deep, Jumpers Deep, and Robinson Deep having this end in view, while the new mill at the Simmer & Jack Proprietary Mines, Limited, has 280 stamps erected and in place, and the combination mill of the Anglo and Dreifontein

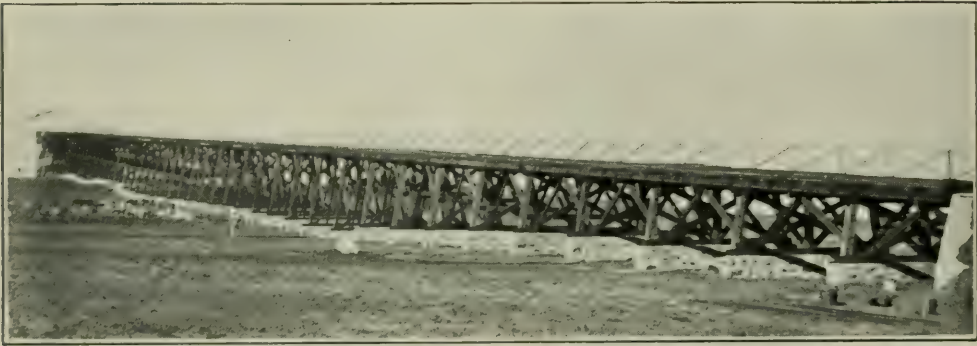
* "Diamonds and Gold in South Africa," by T. Reunert.



60-STAMP MILL, NOURSE DEEP.
Stamps grouped by tens.

Con. mining companies, now nearing completion, is to have 220. The older mines on the outcrop have mills with 60 to 160 stamps.

Contrary to the practice in mountainous countries, the mills are seldom built on hillsides, so that the advantages of gravitation are not enjoyed. With few exceptions, the ground where the mills are situated is comparatively level, and the ore has to be drawn up an incline to the ore-bins, or, more rarely, raised by means of elevators.



A MILL APPROACH. DREIFONTEIN-ANGELO.

In the more recently constructed mills of the Rand the "banket" is delivered into the mill, after having been sorted and crushed, either at a central station or at stations at the shaft's mouth, and is fed from the ore-bins, by mechanical feeders, to the stamps, where, in the majority of the mills, a preliminary amalgamation takes place in the mortar box. The pulp flows over copper plates for further amalgamation, and in a few instances is delivered to frue vanners for concentration, the tailings going to the cyanide works; but the general practice of the Rand mills is to deliver the pulp direct from the amalgam plates to tailing wheels, or, sometimes, to pumps, to be elevated to the height necessary for the requirements of the cyanide plant, a rough concentration by means of spitzluten being, as a rule, the first step preliminary to the cyanide treatment. Where frue van-

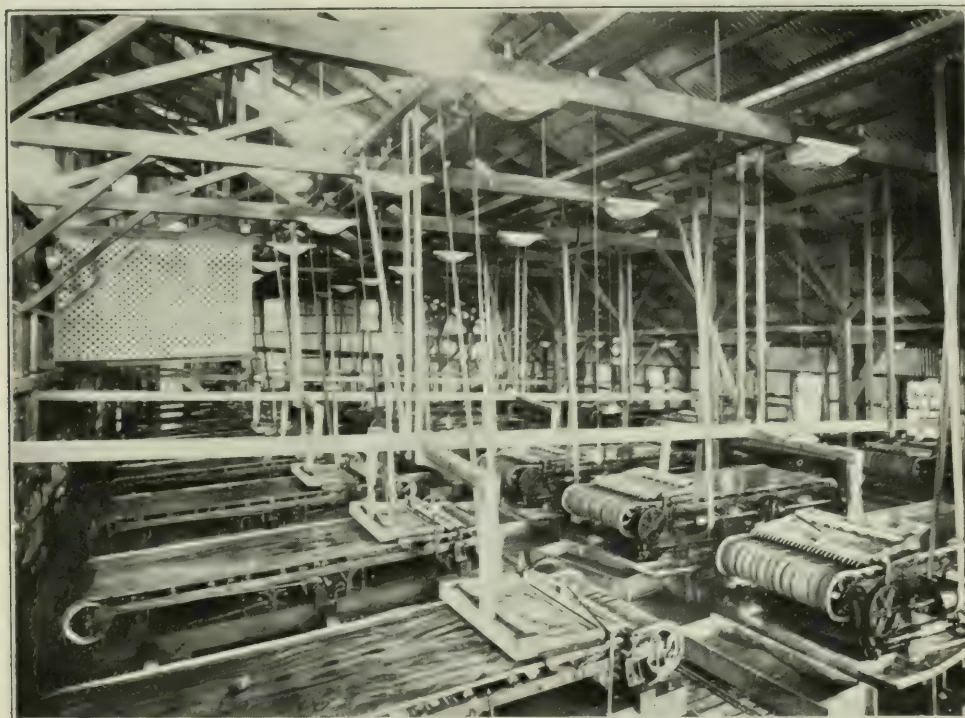


SORTING AND CRUSHER HOUSE AND MILL APPROACH, NOURSE DEEP.

ners are employed, it is customary to use three for every five stamps, but, because of the heavy duty per stamp, they are often overloaded. The product from the vanners, being generally pyrites of high grade, is subjected to chlorination for the extraction of the gold.

The mills are almost invariably placed near the mine rather than near the water-supply. The building itself is framed with timber and covered with corrugated iron. Good foundations are put in, and the construction of the building is very strong. The timber is generally Oregon or pitch pine.

Ore Bins. These are placed on strong masonry foundations, and are made of heavy timbers, well bolted together, the bottoms of the



FRUE VANNERS IN THE WEMMER G. M. COMPANY'S MILL.

bins sloping towards the batteries at an angle of from 40° to 45° . In a few instances, as at the Simmer and Jack and the New Crœsus, flat bottoms are used. Bottoms and sides are usually made of double thickness of 2-inch or 3-inch planks, with a lining of sheet iron. These bins hold from a day's run to four days' run.

Feeders. The use of the "Hendey Challenge Ore Feeder" is practically universal. There is no feeding by hand anywhere.

Mortar Boxes. These resemble the homestake pattern, the main differences being in the height of the feed opening and in the length and width of the boxes. Fraser and Chalmers and the Sandycroft foundry have supplied most of the batteries. As the stamp mills on the Rand



SIMMER & JACK STAMP MILL.
Stamps grouped by twenties.

are rather larger than the average, the mortar boxes, too, are larger and of greater thickness. At the issue the boxes vary between $11\frac{1}{2}$ inches and 18 inches. Most of the mortars have heavy cast-iron or steel linings in the front, back, and sides of the boxes, to insure a longer life. Below the dies false bottoms of cast iron are put in. Several thicknesses are often employed, to insure uniformity of depth of discharge as the dies wear down.

The mortars are placed on piles 12 to 15 feet in length, which rest on $1\frac{1}{2}$ to 2 feet of concrete. The piles consist of heavy pine timber about $14\frac{1}{2}$ inches square, and are bolted together firmly, both lengthwise and crosswise. The pile pits are excavated to hard rock, where possible. The walls of the excavation are built of heavy masonry or concrete, and the space between them and the mortar blocks is filled either with sand, or with tailings well rammed, or with concrete. Between the mortar block and mortar is placed a thick sheet of rubber or, occasionally, felt. The boxes are held down by eight bolts about $1\frac{1}{2}$ inches in diameter, which at the lower ends are recessed into the wooden piles and are held by cotters. They are tightened by nuts on their upper ends. There is plenty of clear space about the batteries, and all bolts can be easily reached.

Screens. These are of well-woven iron or steel wire. The meshes range in number between 500 and 900 to the square inch, 700 be-



ARRANGEMENT OF FRUE VANNERS IN GEORGE GOCH MILL.

ing very common. The area of the holes ranges from .004 to .007 of a square inch. The life of the screen is very short,—between two and three days on the average.

The height of discharge in a battery is regulated by the use of chuck blocks as the dies wear down, or by having several sets of screens, which may be inserted from time to time. The width of the lower sides of these varies. The custom is to employ from two to three chuck blocks. There is a considerable variation in the height of the discharge. When amalgamation in the battery is considered an important feature, the discharge is raised; where rapid crushing is considered of more importance, a lower discharge is employed.

Stamps, Shoes, Heads, Tappets, Dies. The first stamps employed on the Rand were considerably lighter than those favoured at present. Stamps weighing from 750 to 850 pounds, the other parts being light in proportion, were used at first. In all the batteries now being erected, and in those that have been built within the last year and a half, the tendency is towards very heavy stamps, the weight varying between 1,100 and 1,250 pounds. The mills being erected under the supervision of the Rand Mines, Limited, have stamps averaging about 1,150 pounds; those erected at the Simmer & Jack and at the Robinson Deep weigh nearly 1,200 pounds. Even with the old style of stamps, by adding extra tappets or putting in heavier heads, the weight has been increased, and, in consequence, the crushing capa-

city. According to the State mining engineer's report for 1896, the average weight of stamps was 973 pounds. In order to equalize the weight, it is the custom in some mills to use in one set of batteries heavy heads, and in another set lighter ones. New shoes are placed first in the second set, which, after being worn, are taken off and placed in the first. By this means the light heads always have the heavy shoes, and the heavy heads the partly worn shoes.

Shoes, Heads, Dies, Stems. Shoes are made of various varieties of steel, such as Chrome, Hadfield's Manganese, Firth's cast steel and



ORE-SORTING FLOOR, FERREIRA GOLD MINING CO.

forged steel, etc. They range in weight from 180 to 240 pounds. They are $8\frac{1}{2}$ to 9 inches in diameter, and in height 9 to 12 inches. Heads and tappets are made of cast steel, the former weighing from 260 to 365 pounds and the latter from 106 to 130 pounds. Dies are $8\frac{1}{2}$ to 9 inches in diameter and 6 inches high from the top of the 1-inch hexagonal bottom. They are made of Firth's, Hadfield's Manganese, or forged steel. Stems are tapered at both ends, and are made of faggotted iron. They range in weight from 350 to 475 pounds, and in diameter from $3\frac{1}{4}$ to $3\frac{3}{4}$ inches.

Batteries. It is customary the world over to have five stamps to a battery. On the Rand two batteries are usually placed together, with a clear space of five to six feet between them and the next pair, each battery having its own cam shaft and separate driving-wheel.



DREIFONTEIN-ANGELO 220-STAMP MILL.

In some cases one cam shaft and one driving-wheel serve for ten stamps. At the Simmer & Jack four batteries are placed consecutively, with two driving-pulleys and two cam shafts. The plan of having one driving-pulley for each five stamps is favoured by the mill men, as the delays occasioned by necessary repairs affect a smaller number of stamps at a time. Cam shafts are made of faggotted iron, and range from 5 to $6\frac{1}{2}$ inches in diameter.

Cams. Cams are made of cast steel, and vary somewhat in design and in the manner in which they are attached to the shaft. The Blanton cam is deservedly popular; there are no keys, the cam being fastened to the shaft by means of a circular wedge, which is prevented from slipping by the short pins dropped into recesses in the cam shaft. This causes great saving of time in attaching cams and in replacing broken cams on the shafts. The George Goch has introduced for trial on one battery a cam which, instead of having a circular opening, has a decagon fitting on a cam shaft of the same section.

Drop and Speed. The drop of the stamps ranges from 7 to 9 inches, the average being about 8 inches. There is, perhaps, less variation in speed, this running from 92 to 104, the average being about 96.

The order of drop is usually 1-3-5-2-4, although 1-4-2-5-3 and some others are employed.

The amount of water used in crushing ranges from 8 to 9 tons, per ton of ore crushed. This does not mean that that amount of

make-up water has to be supplied, as the water is used over and over again, the only loss being due to leakage, evaporation, and absorption by the tailings. This loss, or make-up, is estimated at 25 per cent.

Copper Plates. Apron plates are universally adopted. Inside the

COMPARATIVE TABLE.

MINE.	No. of stamps.	Weight of each stamp.	No. of drops per minute.	Height of drop in inches.	Average depth of discharge in inches.	Crushing capacity per stamp.	Mesh of screen.	Cost of milling.
								s. d.
Bonanza.....	40	1150	96	8½	4½ to 6	5.43	700	4 3.50
City & Suburban.....	160	1000	96	7½	5½	5.01	700	3 9.58
Crown Reef.....	120	956	97	8½	4½ to 6	4.97	700	2 8.13
Ferreira.....	80	850	94	8½	4	4.38	700	3 4.29
Geldenhuis Estate.....	120	950	97	8	6	4.75	700	2 5.02
Geldenhuis Deep.....	200	1050	96	8½	5 to 7	4.38	700	3 2.76
Jubilee.....	50	950	95	8		3.75	600	
&					4			2 4.00
Salisbury.....	50	900	95	8		3.75	600	
Meyer & Charlton.....	80	1000	94	8	2½	4.34	500	2 9.74
New Primrose.....	160	1088	96	8	4½	5.28	600	2 8.64
New Comet.....	60	1050						
	40	1250	96	8	3	4.21	600	3 1.88
Robinson.....	120	930	97	8½	4 to 5	4.60	800	3 8.34
Simmer & Jack (new mill).....	280	1250	95	8 to 9½	6¼ to 7¾	....	600	
" " (old mill).....	100	1000	95	8½	....	4.49	600	3 11.08
Wolhuter.....	100	1050	95	7 to 8	3½	4.62	500	3 1.84

MINE.		Metal worn per ton of ore crushed.	Cost per ton of ore crushed.	Total cost for shoes & dies per ton of ore crushed.	Loss of mercury per ton of ore crushed.	Cost of mercury per ton of ore crushed.	Life of screens.
		oz.	pence.	pence.	oz.	pence.	hours.
City & Suburban.....	Shoes	8.10	1.75	2.50	.24	.44	36 to 38
	Dies	3.50	.75				
Crown Reef.....	Shoes	8.00	1.37	1.97	....	....	....
	Dies	2.80	.60				
Geldenhuis Deep.....	Shoes	9.42	1.61	2.93	.13	.24	60
	Dies	6.10	1.32				
Meyer & Charlton.....	Shoes	12.80	2.20	3.11	....	....	....
	Dies	4.20	.91				
New Comet.....	Shoes	11.00	1.89	3.32	.42	.77	46
	Dies	6.6	1.43				
Simmer & Jack.....	Shoes	8.48	2.60	2.60	.24	.40	72
	Dies	3.84					



CHAIN SORTING BELT, MEYER & CHARLTON G. M. CO.

batteries both back plates and chuck plates are used, but the former are the most common. In some mills lip and splash plates are used. Apron plates are from 10 to 12 feet long and from $4\frac{1}{2}$ to 5 feet wide, and incline from 1 inch to $1\frac{3}{4}$ inches to the foot. Sometimes they are broken, but usually continuous. Back plates are from 7 to 11 inches wide, and chuck plates from 3 to 6 inches. The copper plate used is from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch thick. They are rarely silver plated, and, when a new mill starts up, considerable time elapses before the plates cease to absorb large amounts of gold.

One of the points of great difference in the Rand Mills is in the arrangement of the line shafts. These are either coupled directly to the mill engine or driven by rope-transmission. The latest mills erected by the Rand Mines, Limited, employ direct coupling with the engine at one end. The new Simmer & Jack Mill uses rope-transmission with two line shafts, one for each side of the mill. In the old Simmer & Jack Mill, where the batteries were in line, the mill engine was placed in the middle, with fifty stamps on each side and with direct coupling. The Witwatersrand Mill has the engine in the middle, but the line shaft is driven by rope-transmission. At the Geldenhuis Deep one line shaft is coupled directly, while the second is driven from the first by rope-transmission. Direct coupling works exceedingly well.

Between the line shaft and the cam shaft various forms of belt tighteners are used. In many of the later mills patent clutch pulleys are employed, doing away with the tightening gear.

Mill Engines. Very excellent power installations are the rule. In many instances the engine drives not only the mill itself, but also the tailings wheel, the electric light plant, the electric precipitation plant, the shops, and sometimes the crushers.

Both vertical and horizontal engines are used, but the latter are in the majority. The usual type is the horizontal compound condensing engine with Corliss valves. To avoid delays an auxiliary engine is sometimes installed. This, of course, is a much cheaper engine than

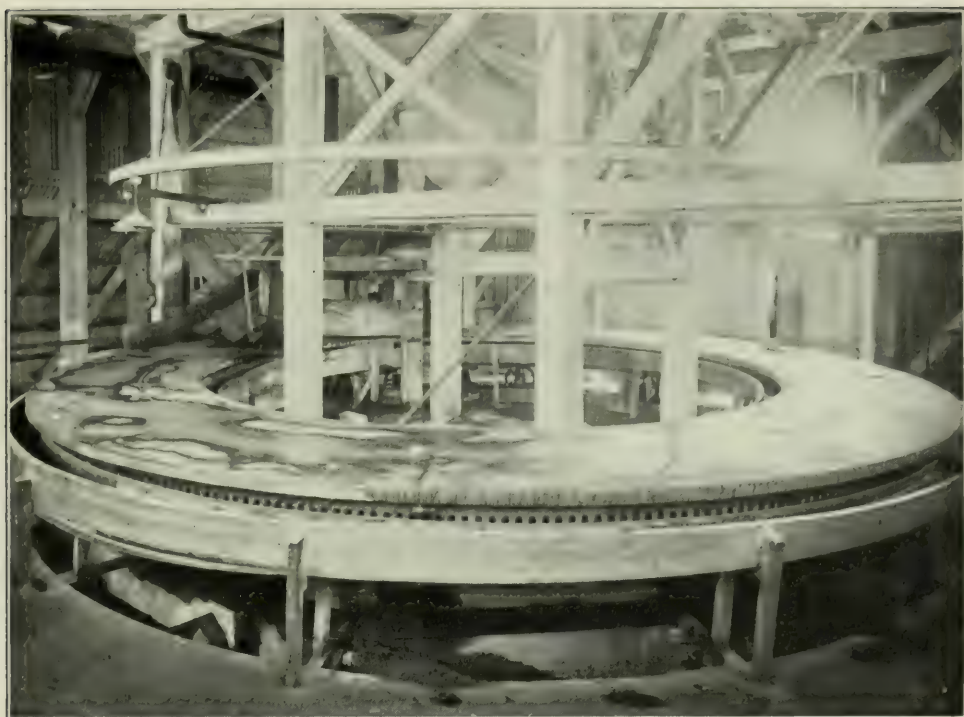


CROWN REEF MILL ENGINE ROOM, SHOWING ROPE DRIVE.

the main engine, and, while not compound condensing, is so made that it can be compounded if desired.

The mills are well supplied with mercury traps made of wood, or, preferably, of iron, and have large and well-constructed launders with ample grades. One or more overhead crawls are used along each line of stamps for the rapid handling of the heavy parts of the batteries. The use of electricity for lighting is almost universal, and the old-fashioned, badly-lighted mill has become a thing of the past.

Clean up Room. This is well supplied with benches and the usual appliances for cleaning up. A pan, barrel, or batea run by machinery is used for the clean-up from the mortars. During operation the outside plates are rubbed every four hours, and the amalgam removed once a day. The general clean-up is made once a month. The percentage of extraction by amalgamation varies, but the average



REVOLVING CIRCULAR ORE-SORTING TABLE, CROWN DEEP G. M. CO.

is from 55 to 65. Retorting and melting are not done in the mills, melting being done mainly in the assay office.

Labour. The amount of labour used is considerable, and, where one white man is employed in other parts of the world, at least one white and one native are employed on these fields. The following table shows the labour employed by a mill of 100 stamps:

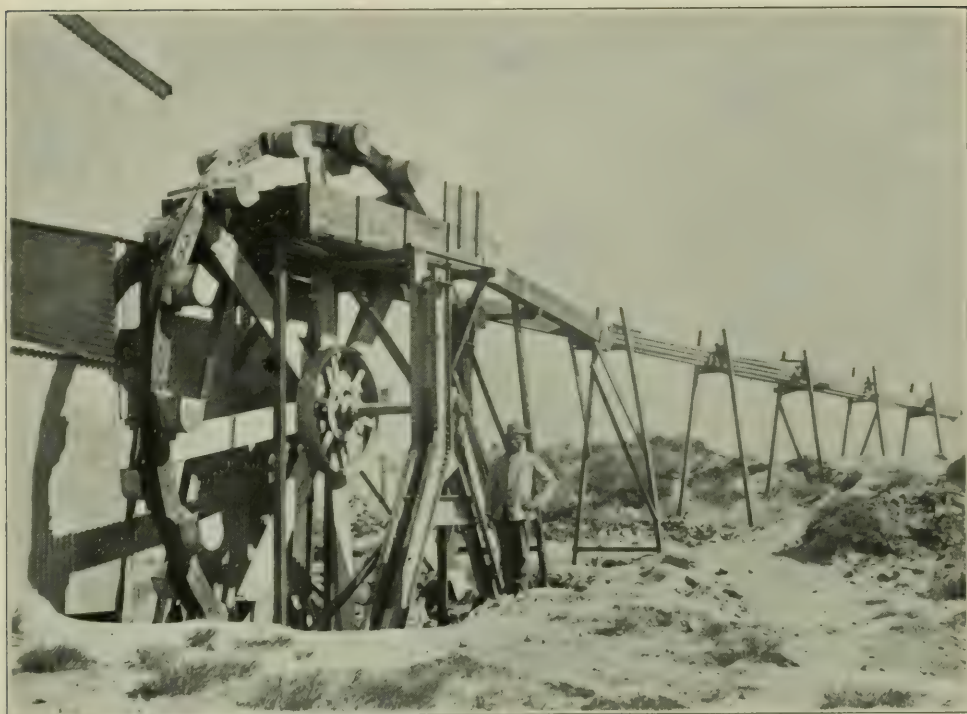
Labour Employed at 100-Stamp Mill.

4 amalgamators per shift of 8 hours.....	12
1 engine driver per shift of 8 hours.....	3
1 blacksmith 9 hours shift.....	1
1 carpenter 9 hours shift.....	1
1 fitter 9 hours shift.....	1
1 hoisting engineer 9 hours shift.....	1
1 greaser.....	1

Whites.....	20
10 natives, assisting amalgamators, shift of 12 hours....	20
10 natives assisting mechanics.....	10
10 natives hoisting and dumping.....	10

Natives.....	40
--------------	----

Tailings Wheels. Where lifts of more than 40 feet are necessary,



AN OLD-STYLE TAILINGS WHEEL.

plunger pumps are commonly used. The latter have given good service where the proper arrangements have been employed to apply clear water to the plungers to prevent scouring. However, for lifts of less than 40 feet the tailings wheel is most satisfactory, requiring but little power and little or no attention. These wheels are patterned after those used at the concentration works of the Lake Superior copper mines.

The temperature being so mild, there are no troubles due to freezing. Tailings wheels, launders, spitzkasten, etc., need no shelter.

The mill of the Simmer & Jack Proprietary Mines being the largest gold mill in existence, and a type of modern mill-construction, a description of it is given here: Built on level ground, as are most of the mills on the Rand, the approach to the ore-bins is a raised earthen embankment having a $2\frac{1}{2}$ -per cent. grade, over which are drawn, by locomotives, trains made up of trucks of 20 tons' capacity each, which supply the mill with ore from the different shafts of the property, where sorting and crushing have already taken place. The mill building is 269 feet long by 100 feet wide, exclusive of the engine room and boiler house, the frame being of wood covered with corrugated iron.

The ore-bins are rectangular in cross section, the bottoms being flat, and have a capacity of 6,000 tons, or about four days' supply, with the full mill in operation.

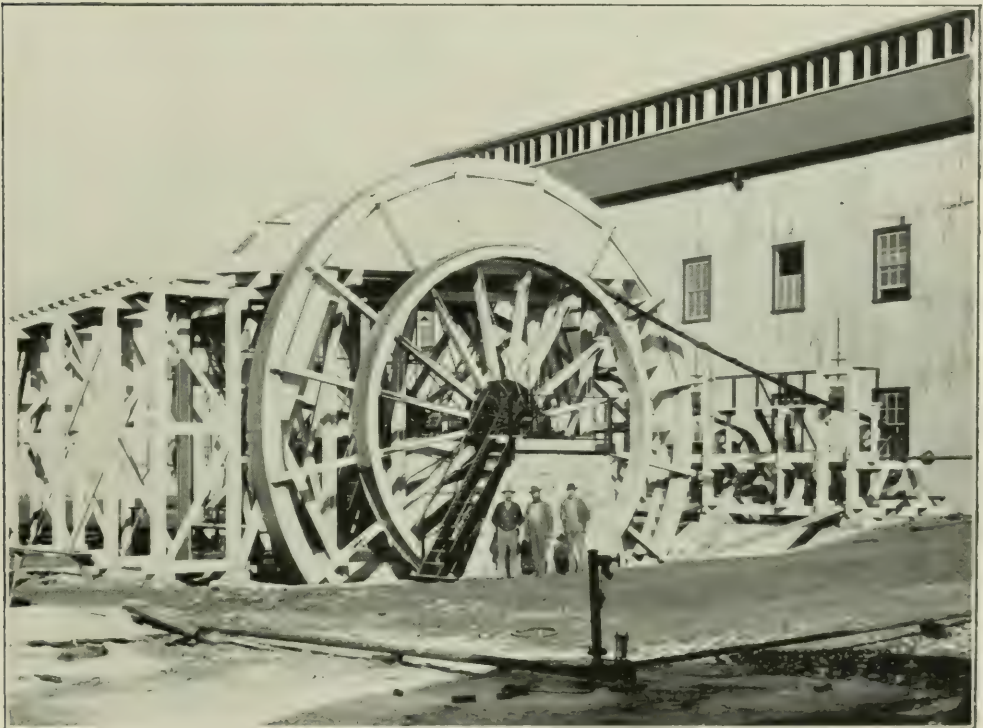
The mortar blocks consist of eight karri wood piles bolted together, and the mortars are 4 feet 10 inches in length by 4 feet 8 inches in height, and are lined with steel. The sides are 1 inch in thickness, and the bottoms 9 inches.

The feed opening is 3 feet 2 inches above the base, and has a width of $3\frac{1}{2}$ inches for the full length of the box. The height of the discharge is $6\frac{1}{4}$ to $7\frac{1}{4}$ inches, and the screens, of 600-mesh steel wire, are $51\frac{3}{4}$ inches long by 10 inches wide, and have a life of three days, costing .54*d.* per ton of ore crushed. Amalgamation is done entirely on the outside plates or apron. This is a new departure at this property, as at the old mill inside amalgamation was also practised.

The stamps are arranged in groups of twenty, ten being driven by each cam shaft, and weigh 1,200 pounds each, made up as follows:

	Weight.
Shoes, 9 inches by 12 inches.....	221 lbs.
Heads, 9 inches by 18 inches.....	284 “
Stems, $3\frac{1}{2}$ inches by 18 feet double ended	560 “
Tappets, $9\frac{1}{4}$ inches diam. ends by 13 inches	119 “
	1184 “

The dies are 9 inches by 7 inches, and weigh 140 pounds.



NEW STYLE TAILINGS WHEEL, SIMMER & JACK MILL.



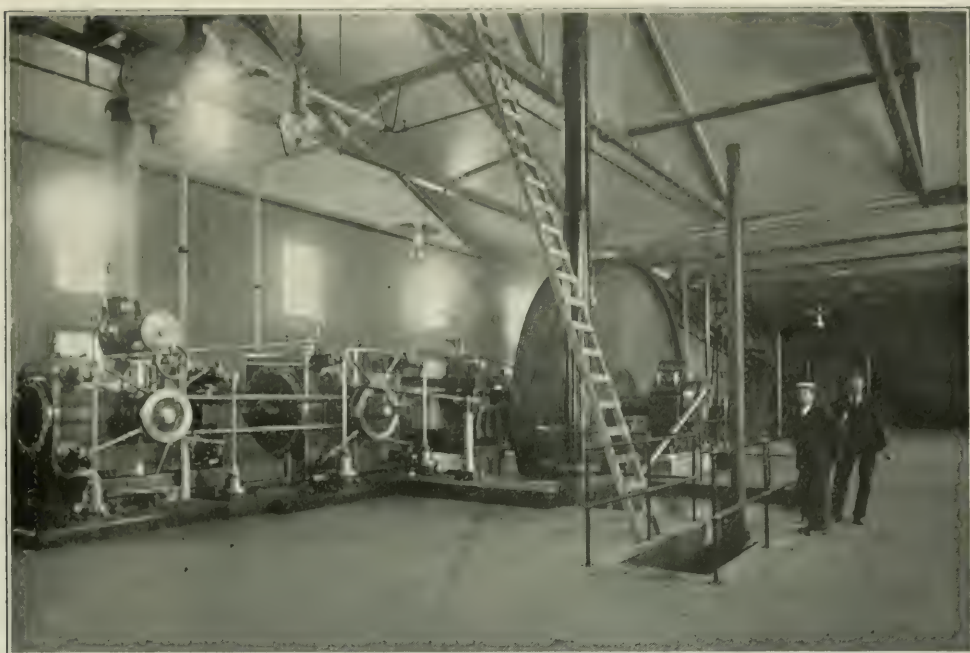
GENERAL VIEW OF THE SIMMER & JACK MILL.

The drop is from 8 inches to 9 inches, and the order 1-5-3-2-4, the minimum of drops per minute being 95.

The cams are of cast steel, and have a sweep the outside diameter of which is $33\frac{1}{2}$ inches. The cam shaft is of faggotted iron with a diameter of $6\frac{1}{2}$ inches, and a length, over all, of 14 feet 3 inches. The cam pulley is of wood, having a diameter of 6 feet and a face of 17 inches. An overhead trolley is arranged under the cam platform



MILL APPROACH, RAND MINES CO., LTD.



ENGINE ROOM OF THE SIMMER & JACK MILL.

for transporting shoes, dies, etc., to the mortar boxes. The mill has been running too short a time to enable an accurate estimate to be made of the consumption of iron and cost per ton of ore crushed.

The battery tables have an effective surface 16 feet long by 4 feet $7\frac{1}{2}$ inches wide, a fall of $1\frac{3}{4}$ inches per foot, and are covered with $\frac{1}{8}$ -inch sheet copper; they are constructed with one riffle 10 feet down from the mortar box end. A mercury trap is fixed at the end of each table. The pulp from the mortar boxes discharges on lip and splash plates before beginning the descent of the tables.

There are two complete steel line shafts, one for each side of the mill, ranging from 10 inches in diameter at the engine end to 6 inches at the tail end. The pulleys for driving the cam shafts are 36 inches in diameter and 17 inches in face. The mill is driven by a compound tandem Corliss surface condensing engine, by Messrs. Yates and Thom, with cylinders $24 \times 44 \times 54$, running at 70 revolutions, giving 900 i. h. p. The driving-pulley is 21 feet in diameter, having grooves for 20 $1\frac{1}{4}$ -inch manilla ropes, leading on to a pulley 15 feet 6 inches in diameter on the near line shaft, the two line shafts then being connected with rope pulleys 15 feet 6 inches in diameter for 10 $1\frac{1}{2}$ -inch manilla ropes. Rope-tightening gears are used on both drives.

There are five 200-h. p. Heine boilers with two 200-tube economisers and one steel chimney 100 feet high and $6\frac{1}{2}$ feet square.

The launders in the mill have a 4 per cent. grade, and deliver the

tailings to three 38-foot tailings wheels, to be elevated for delivery to the cyanide works.

Such a gold mill varies but slightly from the general type in California and the west of America. Distinctly different from this in one feature at least, and peculiar to the mill construction of the Rand Mines Company, Limited, is that of the single line shaft coupled directly to the crank shaft of the driving engine,—a style of mill first introduced in the Black Hills of Dakota. Those of this type on the



NIGHT AT A SOUTH AFRICAN GOLD MILL.

Rand are of 200 stamps, or constructed for 200 stamps as an ultimate ; for instance, the Crown Deep, Rose Deep, Nourse Deep, Jumpers Deep, etc.

The ore is delivered to the mill from a central sorting and crushing station, by rope-haulage up an incline, to bins of about 2,700 tons' capacity, and fed by challenge feeders to the stamps.

The mortar boxes are Fraser & Chalmers' No. 102, the height from the base being 4 feet 10½ inches, and length over all 4 feet 10½ inches. The average thickness of sides is 1½ inches ; of bottom under the dies, 9 inches. The box is lined with steel. The height of the feed-opening is 4 feet 4½ inches above the base, and the width is 4½ inches. The height of the discharge is 8 inches, and the size of the screen 700-mesh with a life of 36 hours. Inside amalgamation is practised.

The stamps are arranged in groups of ten, and one cam shaft serves

each group. They weigh about 1,150 pounds each as follows :

Shoes $9'' \times 10''$ & $9'' \times 12''$	Weight	200 to 235 lbs.
Heads $8\frac{3}{4}'' \times 18''$	"	245 "
Stems $3\frac{3}{4}'' \times 15'$	"	540 "
Tappets $13'' \times 9\frac{1}{8}''$	"	130 "
		1,150 "

The dies are 9 inches $\times$ 7 inches, and weigh 118 pounds, having a smaller base than those of the Simmer & Jack. The average drop of the stamps is 8 inches, and the order 1-4 2 5-3, the number of drops being 96 per minute. The Blanton cam is used. It is made of cast steel and has a sweep 31 inches in diameter. The camshaft is 6 inches in diameter and 14 feet 7 inches length over all. The cam pulley is of wood, 6 feet in diameter with a $16\frac{1}{2}$ -inch face.

Tables are of unsilvered copper plates $\frac{3}{16}$ of an inch thick, and have an effective surface of 12 feet by 5 feet, with a fall of $1\frac{1}{4}$ inches to the foot, there being one mercury trap to every two tables. The launders from mill to tailings wheel have a grade of $3\frac{1}{4}$ to $3\frac{3}{4}$ per cent. The pulp is elevated to the cyanide works by means of one 46-foot double-bucket tailings wheel.

Line Shafting. There is one mild steel line shaft underneath the centre of the ore-bins, coupled directly to the driving engine ; the diameter at the coupling is 10 inches, from which it decreases to 9, 8, 7, and finally 6 inches.

The pulleys driving the camshaft pulleys are 54 inches in diameter with a face of $16\frac{1}{2}$ inches, and are fitted with Seymour's patent friction clutch, the speed of the line shaft being 65 revolutions.

The power consists of one main driving engine, a tandem compound surface condensing engine manufactured by the Ingersoll-Sergeant Drill Company. The cylinders are $24 \times 44 \times 54$, running at 65 revolutions, with an i. h. p. of 800. There is also a Corliss auxiliary engine non-compound 28×54 . This, like the main engine, can be coupled directly. Besides running the mill, these engines usually operate the incline haulage and tailings wheel, and often the electric lights, crushers and sorting tables, and cyanide works. There are eight 106-h. p. boilers, made by Fraser & Chalmers, 16 feet 6 inches long and 4 feet 6 inches in diameter.

These two illustrations typify the best mill construction on the Rand, embodying all the points of modern mill building.

The cost of mill construction on the Witwatersrand may be placed at from £400 to £500 per stamp, depending on the size and design of the mill. As a whole, the mill practice, may be considered excellent, metallurgically and financially.

THE UTILISATION OF BLAST-FURNACE GAS FOR THE PRODUCTION OF POWER.

By W. H. Booth.

THE enormous waste of valuable gas which for years has been going on from the blast furnace has been seen, no doubt, very plainly by more thoughtful men, but no avenue of escape from the difficulty has presented itself until within recent years. The gases were used formerly in their crude state under boilers, for the generation of steam to drive the blowing engines, but this was recognised as only a partial utilisation. In the Scotch furnaces coal is the fuel employed,—not coke, as in England,—and, a few years ago, the recovery of the tar and ammonia was attempted with success, the revenue from the bye-products having been a considerable assistance to the Scotch iron trade. But this residuals-recovery plant still left the principal residual, the gas itself, almost useless, and it was only when Mr. B. H. Thwaite noticed the remarkable similarity between blast-furnace gas and the product of the so-called gas producer that the possibilities of blast-furnace gas became evident.

Producer gas consists of one part of combustible gas to two parts of nitrogen with a small proportion of carbon dioxide. The combustible gas is chiefly carbonic oxide, the remainder being free hydrogen and marsh gas, CH_4 . To reduce iron from its oxides a reducing agent is required. This reducing agent is carbonic oxide. How or where formed in the furnace is a matter of dispute. Some aver that carbon at once burns to CO_2 in the presence of oxygen, and then picks up a second atom of carbon, becoming CO. In acting on the iron oxides of the ore and upon the lime flux, a good deal of carbon dioxide is either set free or made by conversion of the monoxide. After passing the zone of reduction, the gases probably contain a considerable percentage of carbon dioxide, and, if the gas could pass off at this point, the furnace index might better please the metallurgists, for it would indicate a better utilisation of the fuel. But above the reduction zone there is more fuel and ore, and the hot gas absorbs more carbon, so that the gases, as they finally escape, are very poor in CO_2 and rich in CO, and possess, therefore, a large store of potential energy.

It was to the utilisation of this that Mr. Thwaite directed his efforts, and he was so far successful that he obtained permission to try

the system at the works of the Glasgow Iron Co. at Wishaw. It was in reference to the writer's tests of this plant that a few figures have already appeared in *THE ENGINEERING MAGAZINE*, and perhaps more details may be acceptable.

The plant necessary to utilise the gas for power purposes is so very simple that there is not much to be said about it. One goes to see the demonstration plant in operation. A pipe is carried from the gas return main of the residuals-recovery plant. This leads the gas to an exhauster, which forces it forward into a holder through a filter placed to deal with any possible remainder of dust. From the holder the gas passes to the engine, and that is all there is to say or to see, in a general way. Five minutes is sufficient to secure a general grasp of the whole plant. In the demonstration plant at Wishaw an engine of 20 h. p. is employed. This engine is belted to a direct-current dynamo supplying current at about 100 volts. It also drives the gas propeller, which draws gas from the main and sends it forward to the holder.

The plant at Wishaw is not run against a brake,—no doubt a very useful method of showing power to engineers,—but it generates electric current, and this current can be measured and forms a very easy check upon the work done by the engine, appealing to the non-technical man better than a mere power-absorbing brake strap. The current thus generated is employed for lighting purposes. At the time of my test there were ten arc lamps in five groups of two in series; one incandescent lamp of 50 c. p.; 11 incandescent lamps of 32 c. p.; and 68 of 16 c. p.

These lamps do duty at the furnaces, the residuals plant, the offices, etc. Useful and paying work, is, in fact, being accomplished by the first attempt at using the gases. So far from there being anything to suggest experiment, the small plant looks as though it had been installed by a firm of twenty years' experience for its duty of lighting the works. Testing such a plant was not a difficult matter. Blast furnaces are known to produce about 180,000 cubic feet of gas for each ton of coal consumed. In the plant tested the holder served the purpose of a meter. It was supplied with gas through a special valve, which could be instantly changed to direct the gas from the blower, by a bye pass, back to the large gas main, thus shutting off the supply to the holder. The holder was 10 feet in diameter, and therefore held 78.54 cubic feet of gas per foot of length.

By measuring the lowering of the holder in, say, five minutes, the consumption of gas by the engine could be ascertained at once, and, the electrical output of the dynamo being known, the gas consumption per e. h. p. could be ascertained. This is better than using the indicator. The engine employed was of Glasgow make,—the Acme,—

running at a speed of 190 revolutions per minute on the usual Otto cycle. As with all engines using gas of "producer" type, it varied slightly from the engines using rich illuminating gas. These alterations comprise, of course, a varied ratio of the gas and air inlet valves, and a change in the piston in order to secure the best ratio of compression.

The electrical output, when the engine was consuming 28 cubic feet of gas per minute, was 85 amperes at 107 volts,—equal to 12.2 electrical h. p. This corresponds with a fuel-consumption of 1.65 pounds per electrical h. p. on the basis of a production of 180,000 cubic feet of gas per ton of coal used. As the day was hot, and the gas was not cooled down to even atmospheric temperature, the measurement of 28 feet, registered by the fall of the holder, did not really represent a consumption of 28 feet at normal temperature. At the time of my tests the blast furnaces were not working quite regularly, and were producing a poor gas. Previous tests had shown 1 e. h. p. to 1¼ pounds of coal fed to the furnace.

When first proposed, metallurgists were inclined to ridicule the idea that blast-furnace gas is capable of utilisation by the gas engine. In the first place, the gas was full of metallic dust, and, in the second place, it contained too much carbon dioxide to explode properly. The dust difficulty can be disposed of in various ways. In a residuals-recovery plant it is mostly deposited in the dust chamber, the remainder being caught in the scrubbers. Dust may also be thrown down by electrical influence, the dust particles aggregating when electrically charged and more readily depositing. The second objection does not hold good, for not only does the gas engine run with the gas, but no one seems as yet to have noticed any misfires. None occurred during the time the engine was under the writer's observation.

In manufacturing electricity by ordinary means a heavy outlay must be faced in works run by water power. Various water power schemes in Southern California, as detailed in *THE ENGINEERING MAGAZINE* of March, 1898, show an expenditure on canals, pipe lines, generating plant, and transmission line varying from about \$75 to \$200 per h. p. If steam be employed, there is a large first cost for boilers and a continuous large expenditure in stoking these, on coal and on water. If producer gas be employed with gas engines, there is the first cost of the producers and their subsequent attendance. With the blast furnace plant these expenses are avoided. The blast furnace is there. It is fed with fuel in the roughest manner, by mechanical means, and even this expense is borne by the primary product of the furnace—pig iron. Thus there is no first cost of steam boilers or gas

producers or water channels. These are represented by the gift of a huge blast furnace, which is an ideal producer of cheap gas and might well be a model for special gas producers. Further, there are no costs for ash removal or clinkering. These products are liquefied in the blast furnace, and are run out by gravity. The blast-furnace plant is thus on a par with water power as regards attendance costs, but does not involve the cost of preliminary works.

The idea may also be looked at from the view point of the iron manufacturer. At present he uses a hot blast, whereby he consumes some of the furnace gas and economises fuel, but he makes an inferior iron. He could dispense with the economy of the hot blast, were he able to sell the gas now employed to heat the air stoves; though this would reduce the production of iron, the product would be of cold-blast quality, and would sell at a higher price, more than offsetting the decrease in volume. Let it be assumed, however, that, after providing for the purposes of the blowing engines and of the hot blast, there remains a fourth of the gas. In America the average output of a blast furnace in 1895 was 712 tons per week. In round numbers the fuel consumed may now be 1,000 tons per week, or 2,240,000 pounds, one fourth of which is 560,000 pounds, or 3,333 pounds per hour. We will base our figures, then, on a furnace which consumes, weekly, one thousand tons of fuel. With one electrical h. p. from each $1\frac{1}{2}$ pounds of fuel-equivalent in the gas, the electrical h.p. of an average furnace, if only a fourth of the gas be used, will thus be 2,222. Assume, however, that a cold blast be decided upon, and that the blowing engines absorb 400 h. p. The total h. p. of the gas will be 8,888, of which 400 h. p.—an excessive estimate—go to the blowing engines, leaving 8,488 available. To heat the blast to $1,000^{\circ}$ will demand approximately one-fifth of the gas, or 1,780 h. p., leaving a net 6,700 h. p. available for outside power. An ordinary hot blast has a temperature of $1,000^{\circ}$ to $1,200^{\circ}$. The waste gases depart at a temperature of 500° . With suitable arrangements and a prospective economy in view, the blast may be heated first by the cooling of the waste gases, and next, if desired, by the usual brick stoves; or, as suggested, the blast may have a moderate temperature only, being merely heated by the cooling of the waste gas on the counter current system. Probably a power of at least 10 e. h. p. might be regularly and continuously obtained by the consumption of each ton of fuel per week, after providing for the hot blast and for the blowing engines, which, of course, would also be gas engines.*

Having secured the means of converting the gas into mechanical

* For particulars as to weight of air and fuel, and waste gases, see *Trans. A. I. M. E.*, Vol. XIX, p. 959.

energy, the next question is as to the use to which such energy can be put. There are various methods :

(1) To establish factories on the spot,—a proceeding limited to a narrow choice of factories, for not every business could be carried on conveniently at the site of an ironworks, for commercial, physical, and labour reasons.

(2) To transport power to a distance by means of wire ropes, which implies an exceedingly small radius of transmission, representing at most an area of a very few square miles.

(3) A system of air compression, whereby a considerable area could be covered by means of expensive pipe lines and at a loss of 30 to 40 per cent. of the energy employed in the compression.

The hydraulic system would be practicable with perhaps less loss than that involved with the last system, but with a much narrower *clientèle*, and the gas itself might be pumped in a more or less compressed state and used in gas engines at a distance. All these methods have great and obvious objections, and they all retire at once to the background when electrical transmission is suggested. By this, the latest of all systems of power transmission, the waste energy of the blast furnace can already be transmitted one hundred miles with a loss of not more than thirty per cent. In a small country like Great Britain, with about fifteen or more centres of iron manufacture, there are immense possibilities. The textile districts of Lancashire and Yorkshire, Leicester and Nottingham, are all within a few miles of blast furnaces. London itself is not one hundred miles from two small iron centres. Birmingham is close to power, and the immediate vicinity of all the larger centres is full of workshops, tramways, and other power users, not to mention the requirements for lighting purposes.

The blast furnaces of the United States would find more than 2,000,000 continuous h. p. on the above estimate of 10 h. p. per weekly ton of fuel. The estimated cost of utilisation plant and thirty miles of transmission line is less than \$60 per electrical h. p.

As regards the qualities of various gases for power production, they are shown by the following result of an analysis of a sample of producer gas, against which is set an average analysis from four blast furnaces, and two from the furnaces supplying gas to the Thwaite plants at Wishaw, near Glasgow, and at Frodingham, near Doncaster.

The proportion of combustible gases is about one-third of the total product. The gas at Frodingham is very poor, but it works satisfactorily in the gas engine.

It may be taken as assured that, when furnace gases shall be generally in demand for power purposes, metallurgists will not experience

	Producer Gas.	Four Blast Furnaces.	Wishaw Furnaces.	Frodingham Furnaces.
CO.....	22.8	30.76	26.78	27.3
N.....	63.5	53.60	57.07	65.2
CO ₂	3.6	14.44	7.38	6.0
H ₂	2.2	0.50	5.20	1.5
CH ₄	7.4	0.80	3.57	.....
O.....	0.5	0.40	.....	.....
	100.0	100.50	100.00	100.0
Per Cent. Combustible...	32.4	32.06	35.55	28.8

any difficulty in supplying such gases with a minimum of CO₂.

At present a high index or ratio of CO₂ is sought for the sake of economy. Sir Lowthian Bell, who is a leading English authority, gives the higher limit of CO₂ as one-half that of CO. More economical working he does not think possible; in the future the endeavour will be towards the lower index. With gas so useful, it is not probable that it will be given away. Indeed, the possibility exists that gas may become a primary product, relegating iron to the position of a bye-product. Without laying stress upon this view, there may still be entertained the hope that furnaces, now unable to compete, and therefore representing so much dead capital, may be enabled to start up again into active life. Indeed, with a demand for power, a blast furnace may be run purely as a gas producer without reference to its power of producing iron or slag. Slag would be made, if required for road purposes, and it might always pay to manufacture some iron, if only to pay for the limestone necessary for a fluid slag to save expense in clinkering. There is nothing visionary in this. At Wishaw, and now at Frodingham, near Doncaster, the system is in operation. This Frodingham plant is of special interest, because the analysis shows a smaller percentage of combustible gas, and proves that even the poorer gases are available for direct use in the gas engine.

Let us see what authorities on iron production have said about the use of blast-furnace gas. In Bauerman's "Metallurgy of Iron," page 267, we read: "If, now, the consumption of coke be 30 tons per day, the gases, if applied to steam boilers, will, by their combustion, raise steam for an engine of 257 h. p."

Bauerman goes on to show that each ton of coke yields 163,450 cubic feet of gases, so that the hourly yield of gas from the above small furnace will be 204,312 cubic feet. If this gas yields only 257 h. p., it follows that it must require 794 cubic feet of gas to yield 1 h. p. when produced through the agency of steam boilers and engines. It is well known that carbon monoxide gas, which burns with a blue, lambent, transparent flame is not efficient for steam raising, owing

to the fact that transparent flames have a very poor power of radiation. Mr. Galbraith, of the Wishaw Works, showed that 1 h. p. was obtained by the combustion of 94.2 cubic feet per hour in gas engines.

The following is the analysis of the gas as given by Bauerman and by Galbraith, together with the thermal equivalents for each :

	Bauerman.	Galbraith.
CO ₂	9.21	7.21
CO.....	26.60	25.83
H.....	1.00	4.55
CH ₄.....	....	3.45
N.....	63.19	58.96
	100.00	100.00

Thermal value per cubic foot at

60°..... 87.67 126.55 B. T. U.

Mr. Galbraith gave brake horse power. Let it be supposed that Bauerman intended brake horse power to be understood ; then the comparison of steam and gas becomes :

Bauerman..... 794 × 87.67 = 69610 B. T. U.

Galbraith..... 94.2 × 126.55 = 11901 B. T. U.

From these figures it is seen that to generate a horse power by steam requires 5.8 times the thermal units required to develop a horse power by gas engines. It may not be out of place to remark here that the output of gas from a furnace appears to range, according to practice, from 160,000 to about 200,000 cubic feet per ton of coal. With the larger yields the gas is proportionately poorer ; it contains more nitrogen, and the power produced demands a larger gas production per volume ; but perhaps no very great difference of power is shown per ton of fuel. Assuming gas production to be an object, there can be no longer any reason for producing starved irons. Undoubtedly the economical tendency of the age forces managers to a course of action which tends, to say the least, towards starving the iron by depriving it of the desirable proportion of carbon contents, which it seems able to secure only under liberal treatment. The production of good iron seems to be possible only with a wasteful furnace. The natural corollary of iron manufacture is thus a rational utilisation of the waste gas, and electricity alone renders possible this desirable result.

A few further figures may be useful in respect of the analysis of producer gas and blast-furnace gas. Blount & Bloxam give the following analyses of ideal producer gas made from carbon only and of the ordinary gas of commerce :

TABLE I.

	Pure Producer Gas.	Actual Sample Producer Gas.	Blast Furnace Gas.
	Per Cent.	Per Cent.	
CO.....	34.4	22.8	26.66
N.	65.6	63.5	54.91
CO ₂.....	....	3.6	18.36
H.....	....	2.2	0.07
CH ₄.....	....	7.4	....
O.....	....	0.5	....
	100.0	100.0	100.0

The use of coal accounts for the presence of the hydrogens, and, even with carbon only, the use of a little water gives a hydrogen content.

Average producer gas has a calorific value of 28 calories per cubic foot, or, say, 111 B. T. U. About one-third the total heat of fuel disappears in conversion to the monoxide, leaving only two thirds available. In the blast furnace the heat produced in the furnace goes to reducing the iron and forming slag and to heating the waste gases to about 500°. Hence the economy in using a counter-current system of cooling the waste gas and heating the blast air.

The same chemists give, for blast-furnace gas, the analysis expressed in column 3 of above table.

In table II are given other analyses from the furnaces at Wishaw and at Frodingham, where the gases are now being utilised. These may be compared with an analysis of generator gas given by Mr. Horace Allen.

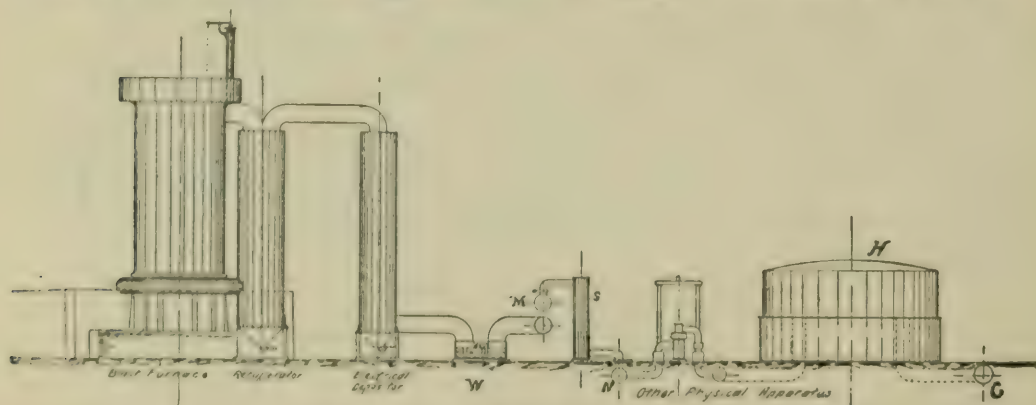
	Wishaw.	Frodingham.	Generator Gas.
Carbonic acid.....	5.75	6.00	6.60
“ oxide.....	24.75	27.30	19.60
Hydrogen.....	2.33	1.50	6.40
Marsh Gas.....	0.75	....	1.30
Nitrogen.....	66.42	65.2	66.10
	100.00	100.00	100.00
Heat Units per Cubic Foot.....	97.8	96.7	98.0

The similarity throughout is very marked. Other analyses show richer blast-furnace analyses, but the two given are sufficient to show that the poorer productions of the blast furnace are almost identical with generator gas.

After a further trial of eighteen months since the writer's tests of

the Wishaw plant, he sees no reason to withdraw anything from what he then wrote. The words used were: "I am compelled to the conclusion that the system is theoretically sound, that it is easy of application, certain in operation, and of almost incalculable value as an adjunct to every blast furnace. The general adoption of the system would free the iron industry from the great reproach, now so justly levelled against it, of gross wastefulness of fuel. Indeed, there is no industry shows less result from a large fuel consumption. The system would have a comparatively poor and restricted field, but for electrical transmission; but with this aid every blast furnace may be set down as equivalent to a fall of water with dam and head canal ready made. The Thwaite blast-furnace-gas power plant is an unqualified success, and entirely practicable in both a mechanical and a commercial sense."

Plans are now in hand for the utilisation of blast-furnace gases at several English iron works, including one at Wigan, which is being prepared with a view to show the transmission of electrical energy to canal towage by means of small motors running on a light rail placed on the towing path. An entirely new plant is also in preparation at Poissy, France, where a blast furnace is being erected for the direct use of the iron for castings instead of for pig. The blast will not be



BLAST-FURNACE GAS PLANT AT POISSY, FRANCE.

hot, but simply moderately heated by means of a recuperator, the air blast being blown through a surface in a direction counter to that of the current. After passing the recuperator, the gases are passed through the electrical depositor, in which the dust is thrown down by the aggregating action of a magnetising charge of electricity. At W is a water seal, whence the gases pass to a longitudinal main, from which they flow through a series of scrubbers, S, placed in parallel between the mains, M, N. Other apparatus, such as transfer valves and filters, are interposed between the scrubbers and the holder, H,

from which the gas engines take their supply of gas by the main, G. This French installation is to be entirely new, from the blast furnace to the dynamos. It embodies the idea of blast only moderately heated, to obtain a good foundry quality of iron for direct casting. The blowing engines will be such as can be driven by gas engines, while the extent of the plant—5,000 i. h. p., to use all the gas produced by the furnace—will be such as to demonstrate on a complete scale the perfect practicability of the use of the waste gases. As compared with my own estimate of 10 h. p. per ton of fuel per week, an estimate by Mr. Horace Allen may be of interest. Mr. Allen assumes two furnaces, making each 800 tons of bessemer pig per week from hematite ore, Durham coke, and limestone. The coke per ton of iron is taken as 20.5 cwt. The following are the figures found by Mr. Allen:

Total pig iron per week, 1,600 tons.

“ coke “ “ 1,640 “ = 9.76 tons per hour.

Gas per ton of coke, 177,240 cubic feet = 1,729,862 feet per hour.

Thermal value of gas per cubic foot, 100 B. T. U.

Total hourly thermal value, 172,986,200 B. T. U.

Cubic feet per i. h. p. per hour 79.12 = 7912 units.

Total i. h. p. of gases = 21,863.

Weight of air blast, 46 tons per hour = 103,040 pounds.

Heat to raise blast to 1,210° F. = 33,488,000 units per hour.

Motive power to produce blast, 1,000 i. h. p., which, if produced by steam boilers, will absorb 542,000 cubic feet of gas per hour, or 54,200,000 heat units, leaving available 85,298,000 units for power purposes, or 10,780 i. h. p.

If, however, the blast were also produced by gas power, some 46,000,000 heat units would be set free for outside power purposes, which would increase the outside power to some 17,000 h. p.—a figure practically identical with my own.

Mr. Allen goes on to show that there is a continuous power available, even on his moderate figure of 6.73 h. p. per ton of iron produced, from which he deduces the motive power to be obtained from different furnaces as follows:

For furnaces making 300 tons of pig per week 2,019 i. h. p.

“ “ “ 400 “ “ “ “ “ 2,692 “

“ “ “ 600 “ “ “ “ “ 4,038 “

“ “ “ 700 “ “ “ “ “ 4,711 “

In whatever way the matter be approached, the possibility is so large that finely-drawn estimates are not needed to prove the enormous field for the utilisation of a hitherto wasted mine of wealth.

HEATING BUILDINGS BY THE WARM-AIR SYSTEM.

By J. J. Blackmore.

THE heating of buildings by warm air is usually understood to refer to the system in which the air is warmed by bringing it into contact with a furnace, and it is with this method of heating that I shall deal in this article. I mention this because buildings are heated sometimes by warm air that has been brought into contact with steam- or water-heated surfaces. Though in these cases the principle is the same, such systems are not usually classed as warm-air heating apparatus.

The principle involved in the construction of a warm-air apparatus is simple and easily understood, but the methods of applying it vary in different localities, depending largely on the comparative skill or education of the parties engaged in the business.

The operation of the system is governed by the forces of heat and gravitation, which are utilized for the necessary movement of the air. A fresh-air duct from the outside leading to the furnace, a furnace to warm the air, and a series of pipes leading to and connected with registers in the different rooms are the appliances necessary to make up an apparatus.

When the apparatus is in use, the outside air is colder than that in the house ; hence it falls into the furnace by virtue of its greater specific gravity. The heat of the furnace expands the cold air, which, as it becomes warmer and lighter, starts up the pipes towards the rooms in which the registers are placed.

If the rooms to be heated have a fire-place in them, or some other means of exhausting the air from the room, a good circulation of the air will result ; but, if the room is without such an outlet, the movement of the air will be slow, for the reason that a room full of air cannot well receive more till a corresponding quantity is removed.

The fresh-air duct or pipe leading to the furnace should never be less than 80 per cent. of the combined capacity of all the warm-air pipes leaving the furnace. If the quantity of air supplied is inadequate, only those rooms most favorably situated will get a supply, and very often, in such cases, air will be drawn down through some of the ground-floor registers to supply the deficiency, the rooms thus drawn from receiving little or no heat.

Figure 1 illustrates the application of a plant to an ordinary house. The pipes vary in length, according to the situation of the rooms relatively to the furnace. If the piping is not carefully planned, the

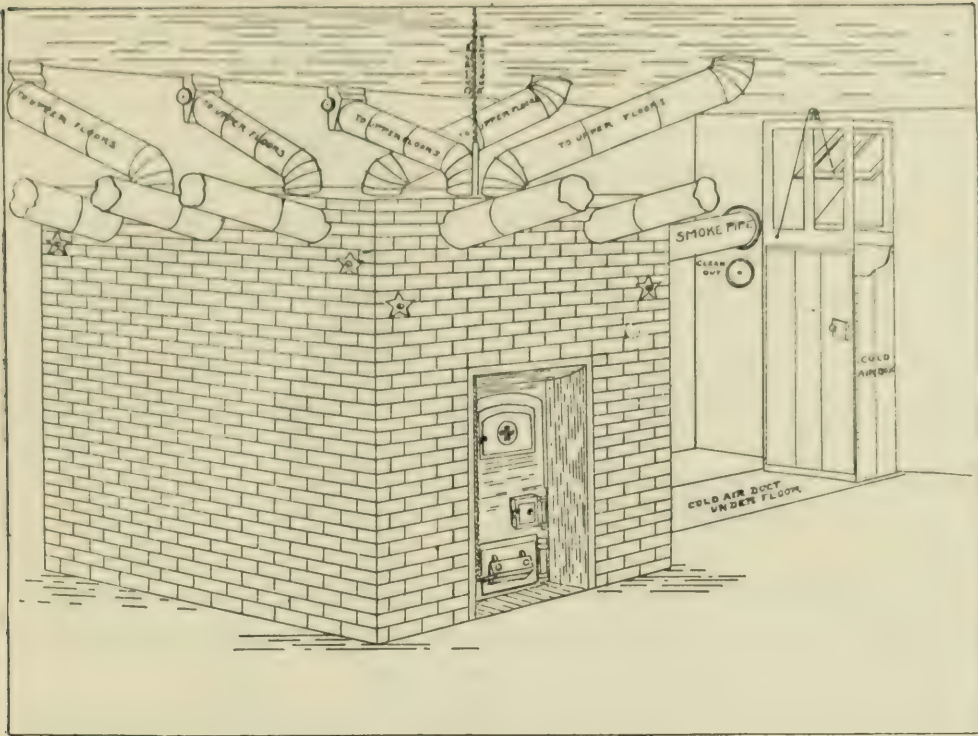


FIG. 1. HOUSE-HEATING FURNACE.

short pipes will take more heat than needed, and the long ones will suffer in proportion. To overcome this tendency, the longer pipes are made of larger diameter than the short ones.

The velocity of the air flowing through the pipes is much less on a first floor than on a second floor; hence pipes leading to the second or higher floors can be made much smaller, and the air will be able to overcome more friction than in the pipes leading to a first floor.

The velocity of flow through pipes to the first floor rarely exceeds three feet per second; but to the second floor the flow may be four feet per second, and to the third perhaps five feet. These velocities, however, cannot be depended on except under good conditions.

To heat an ordinary room it has been found necessary to supply sufficient warm air to equal three, and sometimes four, changes of its entire contents per hour. To heat a room $15 \times 20 \times 10$ on a ground floor a pipe fully 12 inches in diameter is needed, and the velocity of flow must be not less than three feet per second. The discharge of such a pipe in feet is $.7854 \times 3 \times 60 \times 60 = 8,424$ cubic feet per hour,—nearly three times the capacity of such a room.

This rate of change should be maintained steadily while the apparatus is running, and the heat of the furnace should be increased or diminished to suit the outside temperature.

If the horizontal warm-air pipes are long, these results cannot be

obtained with a 12-inch pipe, and the size has to be increased in proportion to the distance of the register from the furnace.

The second-floor pipes discharge from the register at the rate of about four feet per second, but a pipe one-half the size of those used for the first floor will usually supply all the heat needed for the second. The reason for this is that a large amount of heat passes from the lower to the upper floors by circulation independent of the furnace pipes. The upward pitch of the pipes as they leave the furnace materially affects the velocity of the flow; hence the furnace should be set as low in the cellar as possible. The pipes used for distributing the heated air are usually made of bright tin. It is wise to protect these pipes with asbestos and hair-felt covering to prevent loss of heat, especially in the case of long horizontal pipes.

The elbows or offsets needed should be curved to reduce loss by friction.

As each pipe leaves the furnace, it is usually provided with a cut-off damper to regulate the flow of air, as it is nearly always found that some rooms take heat more freely than others.

The registers used in warm-air apparatus are of three kinds. The flat oblong shape is mostly used for floors; the flat round pattern is used for both floors and walls; and the convex oblong pattern is used for inlets placed on the side walls.

The register should be at least 50 per cent. larger than the capacity of the pipe leading to it, for the reason that one-third of the capacity of the register is lost by the obstruction of the fret work of the register face. It is the custom to use a 10×14 register on a 10-inch pipe, a 12×16 on a 12-inch pipe, and so on; but even these sizes can often be increased to advantage.

Thermostatic regulators are now used by many firms to regulate the temperatures of the rooms by closing or opening the dampers of the furnace automatically as the temperature varies. These appliances give fair results, and assist materially in the management of the apparatus.

Some manufacturers advocate large fire pots, others deep fire pots; some use a comparatively small amount of heating surface over the fire pot, and claim that highly-heated surfaces do not have a detrimental effect on the air, while others claim that large surfaces over the fire pot give the best results. A careful comparison will show that the best and most expensive furnaces of all reputable makers have a heating surface definitely proportioned to the size of grate, and that the proportion of heating surface is larger than it is in cheaper grades of heaters. This indicates that large surface areas for the air to impinge upon have been found advantageous. All manufacturers are

not agreed on this point, however. It is a somewhat difficult task for the lay mind to determine which of the various kinds is the best. Without trying to settle the question, I will describe the conditions under which a furnace has to perform its work and how the heat it gives off may be utilized. The first task of the furnace is to burn the fuel properly,—*i. e.*, it must have a chamber where the

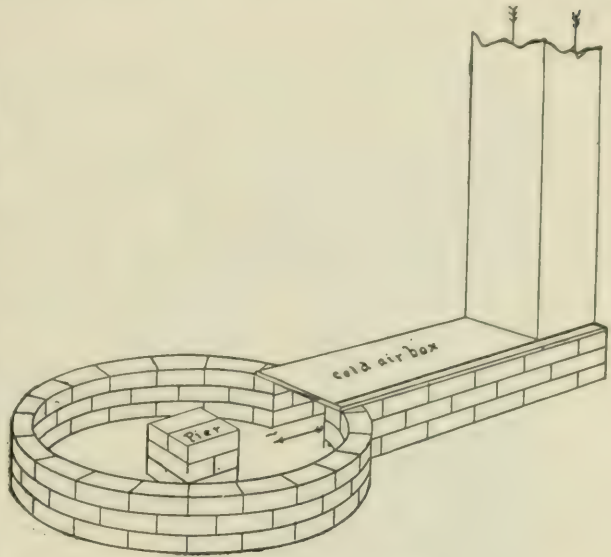


FIG. 2. COLD AIR BOX.

various elements in the fuel and air may be united to produce combustion. This function of the furnace has a much greater importance than is usually ascribed to it, and, as a result, losses from imperfect combustion are frequent. In the burning of fuel rather more than two-thirds, under certain conditions, may be burned to carbonic oxide, an intermediate product of combustion; and, unless this gas can be further converted into carbonic acid, most of the heat which the fuel might have developed goes up the chimney with the smoke. Carbonic oxide is a combination of one part oxygen with one part carbon, usually written CO. The addition of one part of oxygen will complete the combustion, and develop all the heat which the fuel can yield. If the draught of a furnace is poor, or if the fire pot, or combustion chamber, is too small, enough oxygen will not be brought into contact with the fuel, or gases, to enable them to give off the heat that is in them; hence it is important that a good chimney flue should be provided, and that the furnace room should be properly supplied with air. The furnace should have a space above the fuel at least three times as large as the fire pot, to allow the gases room for combustion. The size of chimney required depends, of course, on the size of the house, but a furnace should not be connected to a flue less than 8 inches by 12, and houses containing more than twenty thousand feet of space should have larger flues.

In a pound of the average grade of anthracite coal there are about 14,000 units of heat (one unit is the amount of heat necessary to raise one pound of water from 60° to 61° F.) In burning to carbonic oxide (CO) from 4,000 to 4,500 units only are given

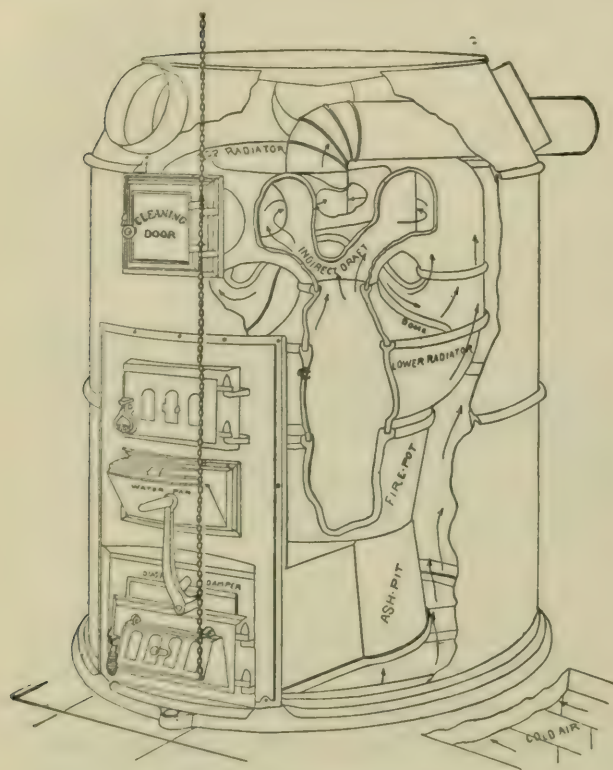


FIG. 3. PORTABLE SETTING.

off; the rest may all be lost through the fault of a poor draught or a badly-constructed furnace.

If a furnace is constructed with a large fire pot and only a small amount of heating surface above it, a large portion of the heat will be wasted (no matter how perfect the combustion may be), for the reason that the air coming into contact with the outer surfaces cannot carry off the heat as rapidly as it is generated, and the surplus escapes up the chimney.

We will now consider how the heat is taken up by the air as it comes into contact with the heated surfaces of the furnace. One thousand cubic feet of air at the temperature of zero weigh 86.4 pounds, and, as the specific heat of air is .238 and the temperature of the air delivered through the registers should be 140° , there would be absorbed by one thousand cubic feet 2,878.4 units of heat, as follows: $a \times b \times c \times d = x$, in which a represents 1,000 cubic feet of air at zero, b the weight of a cubic foot at zero, .08,641; c the specific heat of air, .238; d the number of degrees to which the air is heated, 140; and x the heat units absorbed by one thousand feet of air. To change three times an hour the air-content of a house having a capacity of 20,000 cubic feet absorbs in zero weather 172,704 units of heat, equal to 12.33 pounds of coal per hour, presuming no waste of heat. But, even in well-constructed furnaces, there is a loss of twenty-five per cent.; hence it would be necessary to burn 16.44 pounds of coal per hour to do this amount of work in zero weather. As a fire burns actively for sixteen hours, and at one-half its capacity for eight hours, in the twenty-four, we have twenty hours at the rate of 16.44 pounds per hour, or a consumption of 328.8 pounds per day, or, again, very nearly one ton of coal in six days.

Taking the average winter temperature in the northern portion of

the United States as 40° , it would be necessary to heat the air sixty degrees, requiring $6\frac{1}{2}$ pounds of coal per hour, or, for 200 days, 13 tons of coal.

An apparatus heating and circulating 60,000 cubic feet of air per hour requires a cold-air box, or duct, $3\frac{1}{2}$ to 4 square feet in area, and the air should be so conducted to the furnace as to make it impinge on all parts of the heating surface. The best way to do this is to take

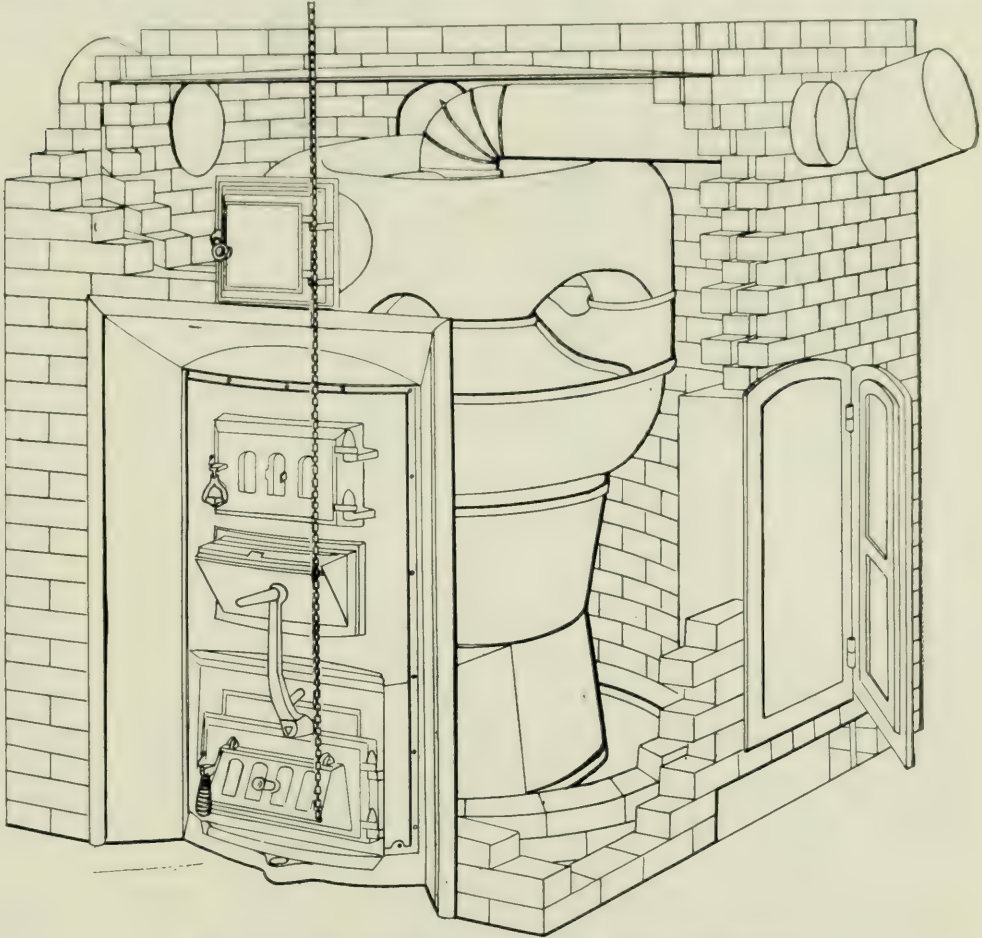


FIG. 4. HOT AIR FURNACE WITH BRICK SETTING.

it to the under side of the furnace, as shown in Figure 2. This enables the air to come up all round the furnace, and to readily take up its heat.

There are two methods of setting furnaces in general use. One, illustrated by Figure 3, is known as a portable setting. The furnace is set inside a galvanized iron casing, with sometimes an inner casing of tin or sheet iron, as an extra means of preventing loss through the casing, and to act as a radiator to take up the heat from the surfaces of the furnace, which is given again to the air as it passes through between the furnace and the casing. The other kind is known as brick

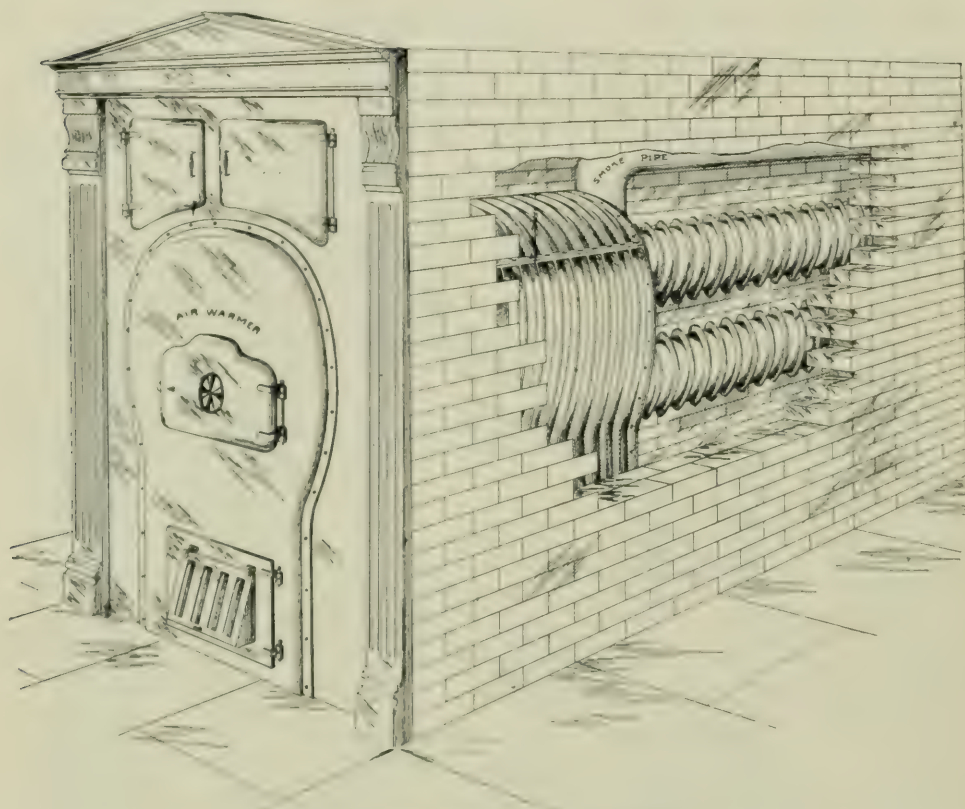


FIG. 5. OBLONG HOT AIR FURNACE.

set, and is illustrated in Figure 4. The method of taking the air in either furnace is practically the same, but the mode of taking the warm air from the brick work is different, as in the brick-set furnace some of the pipes may be taken off the top and others off the side, while in the portable form they are usually taken off the side of a conical-shaped member of the casing at the top of the furnace, as shown in Figure 3.

Furnaces may also be divided into two general classes, those of the round form, shown in Figures 3 and 4, and used mostly for residences, and those of the oblong form, shown in Figure 5, and used for churches, schools, and large buildings where large quantities of fresh air are needed for ventilation.

The heating of a suburban house is attended with more difficulties than that of a house in a city. Suburban houses are much more exposed and often not so well built. When the wind blows strong in any one direction, it become difficult to heat the exposed side, as the pressure prevents the warm air from going in the exposed direction. A city house, with narrow exposures only at front and rear, does not present the same difficulty.

To overcome this a number of manufacturers have adopted a form

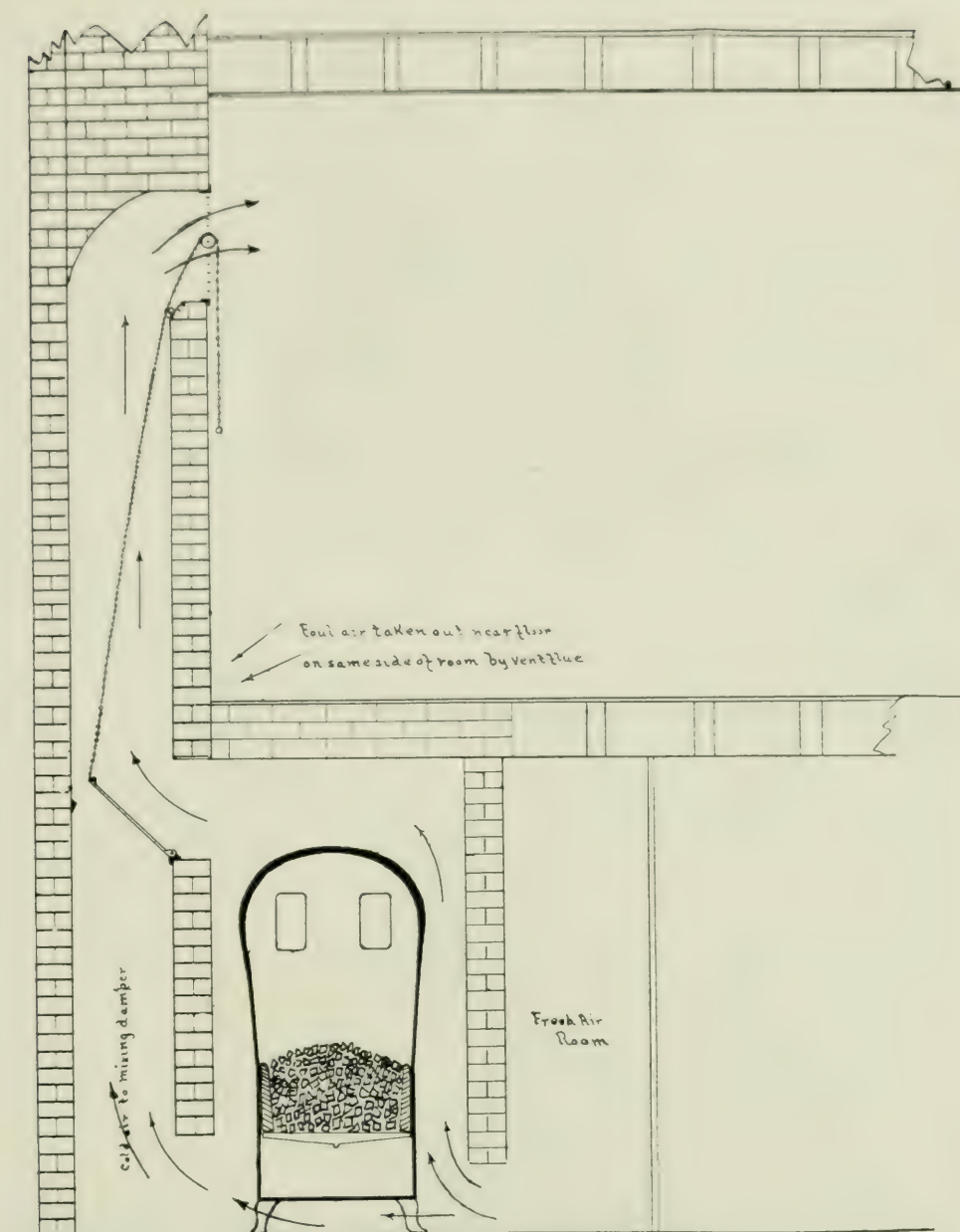


FIG. 6. GRAVITY SYSTEM OF HEATING.

of steam or hot-water generator, which they place in the combustion chamber of the furnace. From this generator pipes are taken to steam or water radiators placed in the exposed rooms, to aid in keeping them at the needed temperature. This adjunct to the hot-air furnace has not proved an entire success, though it has been the means, in many instances, of obtaining better results than could have been obtained by the use of warm air alone.

During the past ten years there has been a great development in the application of the warm-air system to schools, churches, and large

buildings, especially those requiring a large amount of fresh air for ventilation; and it is now common to warm and ventilate the rooms in such buildings to the extent of changing the air in the rooms from eight to twelve times per hour.

A great deal of this work is done by gravitation,—*i. e.*, moving the air by virtue of the heat transmitted to it, and exhausting the air by means of heated flues,—but the best work of this kind is done by the aid of fans. These fans are operated by electricity, gas engines, or water motors. Figure 7 illustrates the usual method of applying the gravity system of warm-air heating in schools. It will be noticed

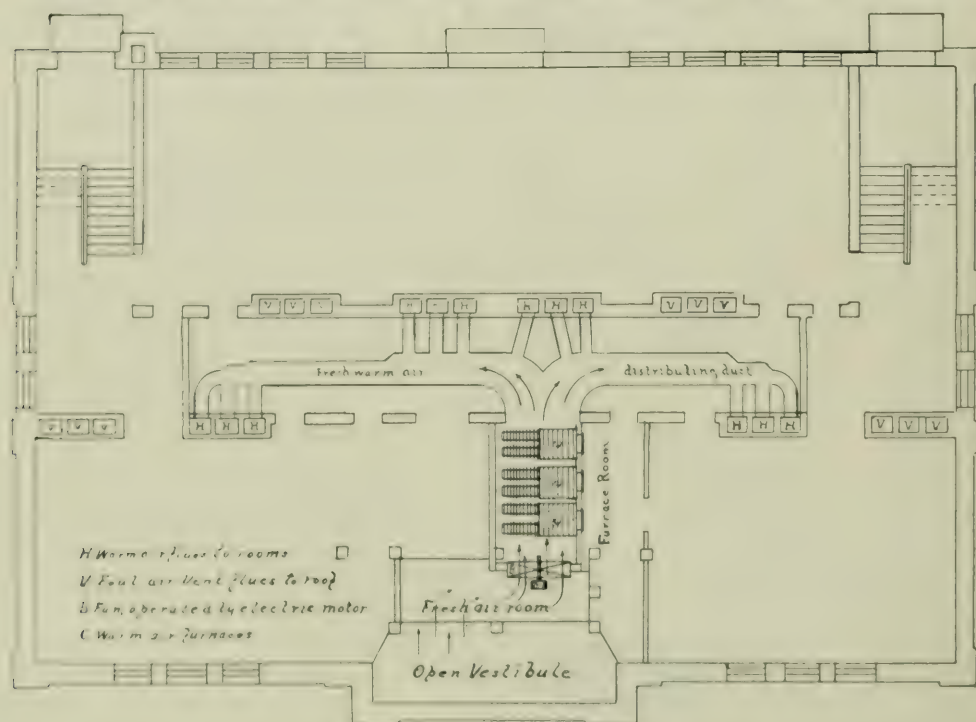


FIG. 7. WARM-AIR FAN SYSTEM.

that the damper in the warm-air flue is so arranged as to change the temperature of the air, but not to shut it off; hence the quantity of air flowing into the room is always the same. If the room gets too warm, the position of the damper is changed to allow more cold air to pass into the flue. These devices are called mixing dampers, and are controlled by the occupants of the room as the temperature varies.

Figure 7 shows a basement plan of a school building in which a warm-air fan system is installed. The furnaces are placed in one room, as close together as the conditions will admit; the fan receives the fresh air from the outside and blows it over and into contact with the heated surfaces, where it is warmed to the desired temperature before it passes into the galvanized-iron distributing ducts, which

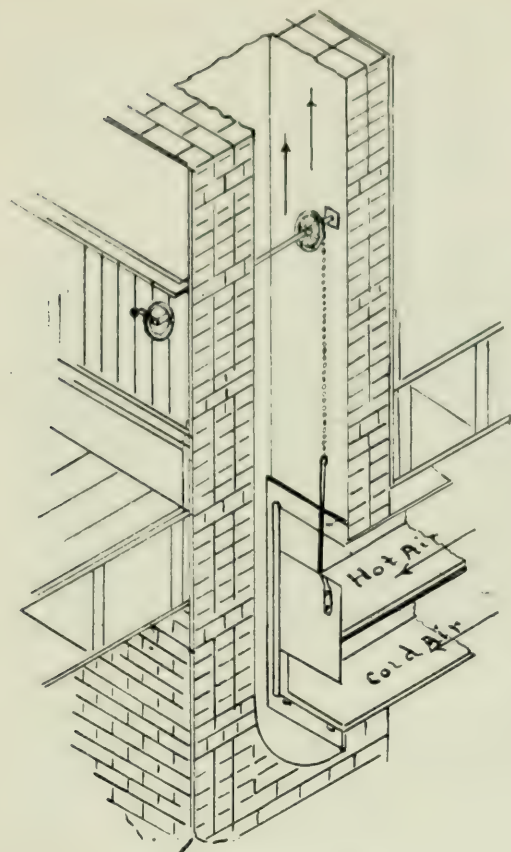


FIG. 8. MIXING DAMPER.

take the warm air to the base of the vertical flues leading to the various rooms. The distributing ducts are usually made double, the upper part containing the warm air and the lower the tempered air, or air that is warmed but little above the outside temperature. The cold air is blown into this duct by the same fan, but is delivered to the duct without coming into contact with the heated parts of the furnaces. The manner of connecting these ducts to the base of the flue, and the position and working of the mixing dampers, are shown in Figure 8. These dampers are frequently controlled by thermostatic regulators, which can be so arranged as to keep the rooms at a uniform temperature and deliver a fixed quantity of air at all times. If an apparatus

of this description is put in by a competent firm, it will always give excellent results, and can be operated with great economy, considering the quantity of air heated. Figure 6 represents a type of furnace used for schoolhouses, and for all work where fans are used to propel the air.

The cost of placing a warm-air heating plant in an ordinary residence is from 1 to 1½ cents per cubic foot of space heated, the price depending on the exposure of the house and on the character of the various fittings used in the plant. For schools, the gravity system costs on an average two hundred dollars per room, counting the main hall as one room, but not counting the teachers' room, and other small rooms as anything. The fan system illustrated in Figure 7 costs about \$250 per room.

UNPROFITABLE ENGINEERING PROJECTS IN WESTERN AMERICA.

By A. G. Allan.

WHILE there are to be found all over the western States a number of different channels in which capital can be profitably invested, there has been foisted on an unsuspecting public in the past ten years a large number of absolutely worthless projects. Millions of outside money have been sunk on the wildest of wild-cat schemes, projected usually by a class of "promoters" peculiar to the west, and always without the slightest regard to business needs or local conditions, ending with the inevitable—bankruptcy. In writing of these schemes, in which so much money has been lost, the writer desires most earnestly to impress on the readers of *THE ENGINEERING MAGAZINE* that there is plenty of good scattered among the bad (if not, it would have been impossible to have got rid of the worthless), and that it is the local conditions peculiar to the western United States that make these schemes so easily workable.

Outside of the railroad question, which we will not consider here, the largest development work in western America has been along the line of irrigation. We all have heard of the great engineering feats accomplished, the large sums of money spent, the enormous amount of desert land made valuable, etc. The question naturally arises: "Do these large canals pay?" The answer must be: "They do not."

In the richest and oldest irrigated farming community of Colorado only one canal in five has ever paid its expenses, only one in eight has yielded any profit, and two out of five of the largest canals have resulted in absolute loss. This is not an encouraging showing. Some of the various causes the writer will now point out.

In one case a number of farmers who had been dried out several years in succession organized an irrigating company for the purpose of voting bonds to build a canal. If any canal should have paid, this should. There was plenty of water, easily obtainable; the canal was very short, with a small cross-section in a light soil; and the farming land to be irrigated, though it looked as level as a floor, had sufficient fall to allow thorough flooding. Alas! the project was a terrible failure. The bonds were voted, and finally sold to representatives of eastern capital for nearly face-value, with interest at the rate of eight



A DRY CANAL, TAKEN FROM A DRY CREEK, DUG TO SELL DRY LAND.

per cent. per annum. A grading machine was bought, and everything made ready for the work, when it suddenly occurred to one of the projectors that a survey would be next in order. The manager (as is unfortunately the case in nearly all these coöperative projects) was a genuine freak, and decided that, as he could not get a civil engineer for less than five dollars a day, he would do the surveying himself. So he equipped himself with a level on a tripod furnished with peep-sights. Teams and scrapers were put to work behind this



DRY CANAL, DUG TO SELL SPECULATORS' LAND; AND IT DID.



CANAL 40 FEET WIDE, BUT DRY.

\$10,000 invested capital lost by over confidence.

surveyor, and fourteen miles of the canal were completed before the headgates or road bridges were built. When the water was turned in, it refused to travel down the excavation, and a small panic ensued, the writer being hurried to the scene by the moneyed interest only to be compelled to condemn the entire work. So now the wind blows the sand up and down the bottom of that canal, while the eastern capitalists have a very unprofitable western investment.

Railroads do not pay, if they cost too much, or if there is a big swindle in their construction, or if built where no traffic can be developed. So it is with the large irrigating canals, some of which cost too much honestly spent money. In a locality where land with a fair water right sells for \$15 an acre, it will not pay to put water on more land at \$25 an acre. Almost all the large canals cost twice as much as the preliminary estimate. Not that the engineer was incompetent or dishonest. He was probably employed by an unscrupulous "promoter," in collusion with a dishonest banker. If the actual cost of the canal was \$10 per acre, the "promoter" either insisted on an estimate of \$5 per acre, or changed the estimate to that figure.

"With this the banker could make an enticing appeal to the investor. He would figure out one hundred per cent. profit on the water-rights, and often another enormous profit on water rents and assessments of, say, \$1 or \$2 per acre for maintenance. In such cases the 'promoter' and the banker 'got from under' with a big 'rake-off' before the inevitable crash came."*

* *Irrigation Review.*

What the average eastern man cannot understand is the division of water in an irrigating district, and the reason why some of the largest, longest, and therefore most expensive canals are sometimes the driest. In the settlement of a new country the earliest settlers take up the river-bottom lands, which are easily watered by short, small ditches; the next settlers take up lands lying farther back from the rivers; while the table lands out of the river valleys are settled last. To water these latter lands naturally requires long and expensive canals. Now, the irrigated areas are divided into districts, each having a drainage basin, or portion of one.

Each district has a water commissioner, appointed (in Colorado) by the governor of the State, whose sole duty it is to divide the available water-supply, *pro rata*, among the different ditches. As the older ditches have prior rights, the later canals, which cost far more to construct (per acre watered) and cover larger quantities of land, are the first to be cut off by the water commissioner when the supply in the river gets short. Nearly all of the money lost by eastern investors in irrigating enterprises has been sunk in these high line canals.

The day of profitable investment in large irrigating works has gone by, never to return, as far more land is now under ditches than can possibly be watered with the natural supply, while the later canals do not get enough water to enable the farmers to raise a crop.

In a new country, where towns and cities are building up rapidly, there is a chance for profitable investment in building lots. This fact



A GENUINE IRRIGATING CANAL.

is taken advantage of by a certain class of "boomers," who "give away" every alternate lot in order to "enhance the value of the property," or sell lots for \$1 each "to get people interested."

Several years ago the writer, being instructed to make an examination and report, in the interest of some eastern gentlemen, on an investment of this class, journeyed to a small town in the eastern Colorado "rain-belt." This is a region in which crops are supposed to grow without any irrigation, but, since the rainfall every third year, speaking roughly, is so small that only the poorest kind of a crop can



"A GARDEN TRACT GIVEN AWAY."

be raised, the cash value of a quarter section of land (160 acres) is from \$250 to \$300.

Arriving in the town, which contained a few houses and perhaps 150 inhabitants, the writer spent some time in finding the headquarters of the "improvement company," as in such a place one has to be diplomatic enough to obtain the information required without asking too many questions. The office of this widely-advertised concern was not more than 8 by 10 feet in size, the furniture consisting of two chairs and a table, and the nearest "addition" to the town was several miles away. The "company" really gave deeds to a 25-foot lot (?) of desert, charging \$4.95 per lot for making and recording the deed. As the county clerk recorded at special rates "by the thousand," so that the total expense, including the purchase price of the land, did not exceed 70 cents per lot, and as the "company gave away" several hundred lots per day, the business was very lucrative.



LAND TO TRADE FOR HORSES, PIANOS, OR ANYTHING.

Another instance of this nature, exploded a short time ago, shows the manner in which these schemes are handled. A short distance from one of the richest farming and market gardening spots to be found anywhere in the west there is some very rough and rocky land. This land was originally "homesteaded" by a sawmill owner for the purpose of utilizing the scrub pine trees growing upon it. Most of the logs were got to the mill by sliding them down the steep side-hills. Having obtained everything of any value from the land, the



A GENUINE COLORADO POTATO FARM,—260 BUSHELS TO THE ACRE.



A DRY RESERVOIR, PHOTOGRAPHED FROM THE INTERIOR.
The view is toward the place where the spillway used to be.

owner left for parts unknown, turning over his real estate in payment of a small grocery bill. After numerous transfers the land was platted, placed on record by a real-estate broker as a "garden addition," and, on the reputation of the real gardening section adjacent, sold as garden (?) tracts, in some instances being exchanged for horses, pianos, hardware, etc. It is surprising how many people own property in that garden addition.

These land schemes are most easily carried through in a thickly-



A GENUINE RESERVOIR, WITH WATER ENOUGH FOR 600 ACRES.

settled country where real estate is worth something, as it seems impossible that the value of realty there should be less than the annual tax upon it.

Another very profitable line for the "promoter," for many years, was the factory plan. As a simple money-making scheme this was remarkably successful. The *modus operandi* was to first visit some busy town of, say, 6,000 inhabitants, and work up a mass meeting, at which some silver-tongued orator would explain the advantages of factories in raising the value of real estate, increasing population, etc. A committee would then be appointed to secure subscriptions to a bonus



"FARM" BOUGHT BY AN EASTERN INVESTOR, WITHOUT PRIOR EXAMINATION.

or subsidy for the purpose of attracting manufacturers. The "promoter" would then leave for the east, and, on the strength of the cash bonus, float a stock company and issue stock and bonds, often exchanging the corporation paper for useless old machinery, fit more for the scrap heap of an iron foundry than for a new (?) factory. A balloon-frame, or perhaps cheap brick, building would be erected, and the machinery placed in it, and then the skilful "promoter" would draw his cash bonus "for working capital" and move on to fresh fields to conquer. The writer has in mind woolen mills, paper mills, a plow factory, a cracker factory, and an oatmeal mill, built for the different stockholders and respective communities on the above plan.

Of all things that a capitalist ignorant of mining and mines should avoid is investment in a mine on his own examination; yet mines and mining stocks are bought and sold by people utterly without information concerning them, or the companies interested in them.

Professor Lakes, in his "Prospecting for Gold and Silver," says:



"AN OUTSIDE ADDITION TO TOWN," 18 MILES FROM A POST OFFICE.

"On entering a mining camp in the far west, especially in the more remote outlandish districts, an investor or an expert may consider that the whole village, from the hotel bellboy to the mayor (who, by the way, may be the principal saloon-keeper), is in league against him. Directly he arrives, everybody in town wants to know his business; on this he should keep as mum as possible, and, if he can,



A DESERTED MOUNTAIN TOWN, FOUNDED ON THE HOPES OF WORTHLESS MINES

throw pertinent inquirers off the scent. The idea is: 'Here is a capitalist to fleece, and an expert to delude.' Every one, too, has a hole in the ground of his own to present. . . . And, if you mention any property, you will invariably hear it cracked up. The Eastern 'tenderfoot' is somewhat of a 'sheep among wolves' in such a camp. . . . What man ignorant of horseflesh would venture to buy a steed from a professional horse jockey, without taking with him a friend who is knowing about horses? How much more so, in



A GENUINE COLORADO TRUCK GARDEN.
135 sacks onions to the acre—sacks 100 lbs. each.

such a difficult and delicate problem as that of purchasing a mine, is it the duty of an investor never to purchase, or induce his friends to purchase, a mine, until he has employed the services of a competent expert to previously examine it. If the expert's fee should amount to a few hundred, and, after all, he should decide on condemning the property, it is far better for the company to entail this expense, and perhaps lose this small sum, than to involve themselves in the loss of thousands of their own as well as other people's money in a bogus, worthless, or wild-cat scheme."

It is, of course, impossible to give a complete diagnosis of the worthless western company, but a few general hints may be useful. If the following counsel were more widely known and heeded, it would be impossible for any one to float any more of these swindling corporations.

Beware of any unknown land, improvement, or canal company,

issuing stock or bonds in small denominations over a wide area. This is a significant sign, for the small investor never does much investigating, and, the more scattered the distribution of such securities, the more successful is the "promoter."

Never buy small farm mortgages without actually seeing the land, making sure that the land mortgaged is the land viewed. It is not uncommon to find a valuable homestead, with good buildings, and highly-improved land adjacent, divided only by a land line, or fence, from the most worthless sage-brush desert. The farm mortgage a few years ago was one of the quickest methods of permanently investing capital in real estate which would neither pay dividends or increase in value. This, however, was not, and is not, true of the genuinely-irrigated farms, which are good securities for reasonable loans.

While nearly all of the large canals built by outside capital in the western States have come to grief, the smallest and oldest farm ditches are the most profitable property imaginable. Farms relying on the larger canals are, in general, somewhat doubtful as collateral or for purposes of investment, but lands under the small ditches with the earliest appropriations are assured of a crop every year.

Building-lots, in any town, ought to be seen before buying. To invest from a plat is to court disaster. In an experience of fourteen years the writer has examined lots laid out in the bed of a wide river, in dense swamps, as well as on sage-brush and cactus desert, miles from anywhere, which must have been bought by investors from finely-engraved maps showing other features than those actually on the ground. Lots in any western town may be of some intrinsic value, but, if in outside additions, ought to be looked on (until examination) as very doubtful.

The reckless promotion of land, irrigation, town-site, factory, or mining schemes has not been confined to any one State, but seems to have been general throughout the west, the worthless being thoroughly interspersed with the valuable and often difficult to distinguish. No one would buy a grocery store without examination; then, why throw ordinary prudence to the wind, and buy stock, bonds, or interests in an unknown mine, factory, or other corporation, thus paving the way for a total loss of capital, giving the unscrupulous "promoter" a chance to assert himself, and doing not only an injustice to genuine projects, but an incalculable injury to the entire west?

THE GROUND CURRENT OF ELECTRIC RAILWAYS.

A DISCUSSION OF THE CAUSES AND EFFECTS OF ELECTROLYSIS.

By Albert B. Herrick.

IN discussing the action and influence of ground currents in an electric railway, the usual methods of conveying currents should be fully understood.

Following the usual custom of supplying trolley cars with a current of electricity required for their operation, the trolley wire is fed from the positive pole of the generator; the current passes through the motors, performing its work of propelling the car, and then is delivered to the rails. So far in the circuit the current is confined to a definite path. On reaching the rail it may either follow the rail back to the power station, or ramify through the earth; it always follows the path of least resistance. Sometimes it travels by sub-surface conductors belonging to the gas and water companies, but, in passing from one metallic body to another when imbedded in earth, especially that found under city pavements, which is charged with nitrates and ammonia, the current carries with it a certain portion of the conductor on leaving it to enter the earth. It is this action which causes electrolysis of the rails when the current leaves the railroad, and of the water pipes or other conductors when it leaves these to return to the power station. It is evident that, if the current, in passing along the rail, reaches an open joint, it will pass into the earth and back into the rail, bridging this joint. The same action will occur if a joint in an iron water pipe or a gas main offers resistance to the current. The effect of electrolysis can be reduced to a minimum, or to a negligible amount, by taking certain precautions and maintaining a periodical inspection and tests of the return flow.

The rail itself generally offers abundant conductivity, except on very large roads. But, as the rail is not continuous, the conductor is broken up into lengths, which are connected by splice bars. Oxide of iron being a partial insulator, these splice plates do not make a good electrical connection between adjacent rail ends. In order to make the rail a continuous conductor, some way must be found to bridge around and connect the rail ends electrically. The bonding of these rails has been a matter of considerable study, and the evolu-

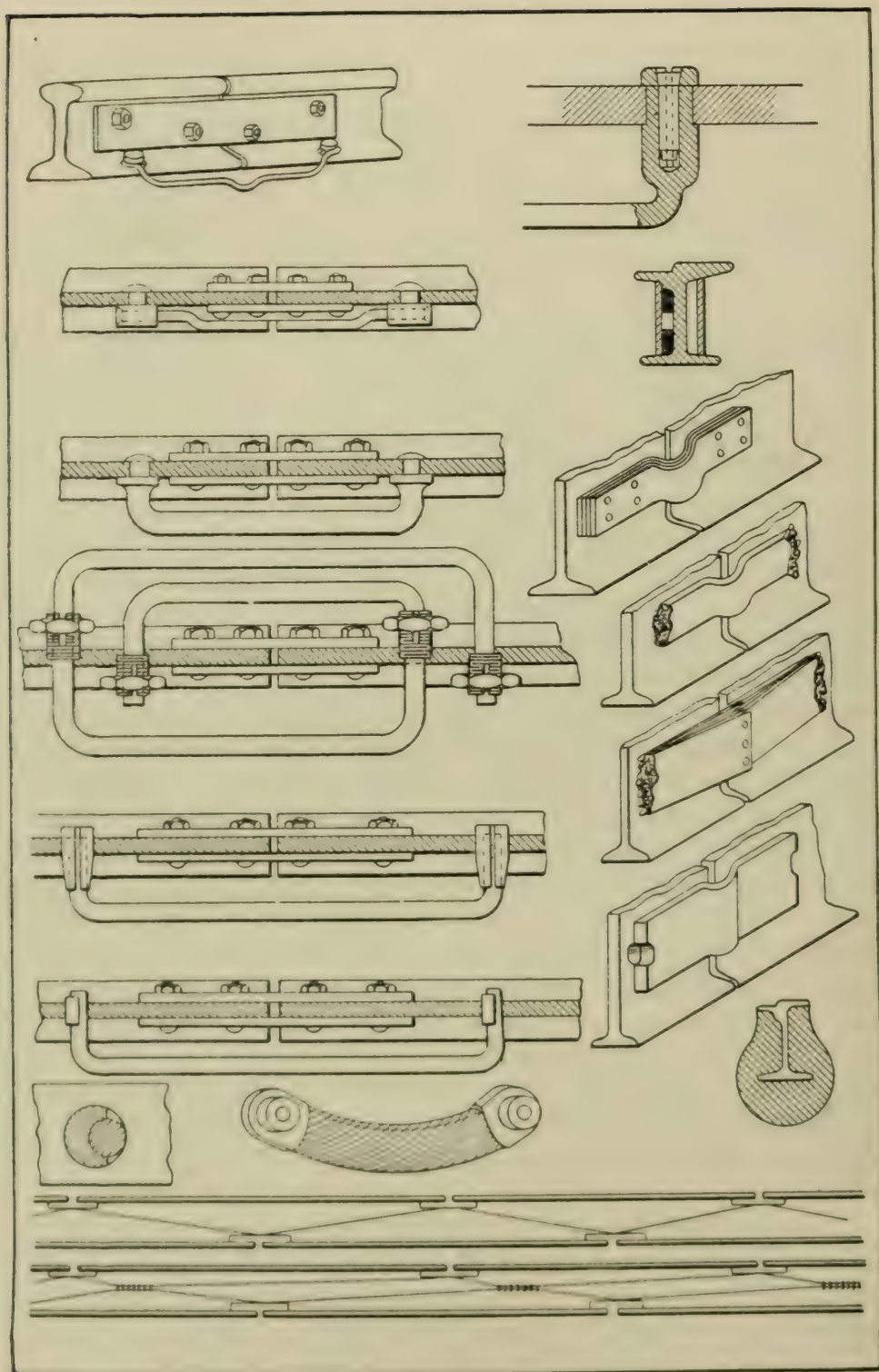


FIG. 1. THE EVOLUTION OF THE RAIL BOND.

Showing the development from the signal-wire connection through the various forms of copper rod bonds, brazed plate bonds, cast-weld joints, etc., to the continuous wire conductor connected to every joint.

tion of the rail bond is given on page 452, where the different forms that have been used are shown. First is shown the simple method adapted from the railroad-signalling systems,—an iron wire secured under the head of a rivet. The next step was to use several of these in place of one, introducing them around the fish plate. The next was to substitute copper wire for these galvanized iron bonds; the matter of making contact between the copper wire and the rails has been the subject of a number of patents, and bonds of various types are now on the market. The channel pin has been used extensively. A hole is drilled through the rail, the copper wire is threaded through the hole, and enough room is left between the hole and copper wire for the introduction of the taper key to connect the rail and the wire. Copper rod, with a rivet head on both ends, is also used for bonds. In another form the copper entering the web of the rail is enlarged, and in it a hole is drilled, into which is forced a taper pin. In another method a split collar is secured in the flange of the rail and thus forced into contact with the copper rod bridging the splice plates. A steel cap split and tapered, has also been used into which is thrust a copper rod, the taper cap being forced into the flange of the rail to secure connection. Another device uses a split ring tapered and forced into the flange of the rail; this ring, surrounding a copper conductor, secures a contact between the rail and the conductor. Such are the principal forms of what is known as the external bond. These bonds are exposed to electrolysis themselves, for the reason that the considerable current traversing them tends at these points of concentration to leave the bond for the earth.

The next step was to introduce a bond between the web of the rail and the inside surface of the tie bar. Bonds in this position can be made much shorter and of larger sectional area, and consequently they form a better electrical conductor between the adjacent ends of the rails. Flexible strips of metal have been brazed to these adjacent rail ends, and bolted together with the rails. Also, a bridge piece of copper has been brazed to both rails. A flat copper conductor with rivets passing through the rail has been used to connect these adjacent ends.

In order to make a continuous conductor between two rail ends without contact surface, an amalgam has been used, making a flexible solder between the conductor forming the bond and the web of the rail. Amalgams have also been used between the web of the rail and the fish plate, allowing the current to be carried into and out of the fish plate in order to bridge the rail end. Beyond this development of an auxiliary method of connecting the rails electrically, the butt ends of the rails have been actually welded together, or iron has been

cast around the rail itself. The latter method has a greater advantage mechanically than electrically.

As the product of electrolysis is in itself an insulator where iron is concerned, the currents traversing the water or gas pipes continually vary, both in quantity and direction, as the continuous action increases the resistance of both, tending to divert the current to other paths. The temperature and moisture of the earth affect these currents.

There is no panacea for the evils arising from electrolysis, but there are general treatments which greatly relieve the condition. The damage is done when the current leaves the water pipe. If these points of departure are determined, by measuring the difference of potential between the rails and the affected system of underground conductors, and if the volume of current flowing through the parallel conductors adjacent to the railway system is known, certain areas where the current leaves the water or gas pipe and returns to the rail or to the ground will be indicated. It is generally assumed, but not correctly, that the difference of potential between the water-pipe system and the railroad indicates the true extent of electrolysis. It does indicate a tendency to divert the current, if the rail is negative to the pipe, but the amount of current diverted can be determined only by electrical measurements on the water pipe itself. The distribution of negative and positive areas must also be considered. The negative areas are adjacent to the power station, whereas the positive areas are the outlying districts. This is the case where the trolley is positive, which is the usual practice. It is evident that, if conductors were attached to the water pipes at the points where they are positive to the rail and carried back to the negative poles of the generators, the current would follow this path in preference to returning through the earth to the rail. This will reduce local electrolysis, but will tend to increase the flow of current through the water pipe, and, if there are any bad joints in the water pipe, the pipe will be badly eaten at these points. Cast-iron fittings and cast-iron pipe are not attacked or destroyed nearly so rapidly as wrought-iron pipe. Lead surfaces and brass nipples connecting lead surfaces with wrought-iron pipe suffer quickly from electrolysis. Gas pipes carrying an insulating medium are not so subject to marked depreciation from electrolysis, unless the ground return of the railway is in very bad shape. There is a condition of water distribution which has to be carefully guarded against. In the old systems of water piping cement-lined sheet-iron pipe was used. Now wrought-iron pipe has been so cheapened that these systems have of late been extended with wrought-iron pipe. With this mixed system of piping the matter of electro-

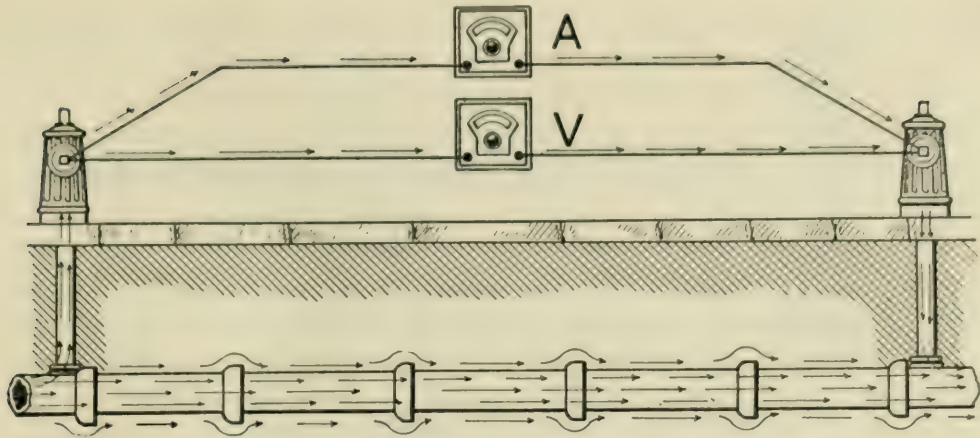


FIG. 2. TESTING QUANTITY OF CURRENT IN WATER PIPES.

lysis may become very serious, as the current enters the wrought-iron pipe on its way to the station, only to be diverted as soon as it meets the high resistance offered by the cement-lined pipe, whereupon it disseminates through all metallic surfaces, such as gates and surface pipes.

It often becomes necessary to determine what should be done by the railway company to protect the property of the gas and water companies from the deterioration due to electrolysis. It is not necessary, as a rule, to impose any great burden on the railway company in order to accomplish this, if the system is gone over carefully and an examination made to determine the causes and localize those points where the action is dangerous.

The methods of determining these localities are very simple, but tedious; the following tests, if properly plotted out, will indicate the points which must be determined before the remedy can be indicated. Starting from the power station, and connecting the rail and the exposed water plug by a voltmeter reading to about ten volts maximum, to be sure that good electrical connection is made on both, a difference of potential will be shown between these two points ranging from one-tenth of a volt to twenty-five volts. It is well to observe this as a car approaches and recedes from the point of test. If the polarity changes; if the pipe is positive to the rail as the car approaches, and negative to the rail as the car recedes,—the car is delivering a large part of its current to the water-pipe system. If two adjacent plugs show a remarkable difference of potential, it is sometimes due to a bad joint in the water-pipe system, between the plugs. The method of testing the current flowing in a pipe is applied as follows: if the tension between two adjacent plugs by means of a long pressure wire can be determined, and if these two plugs then short circuit by means of a cable of low conductivity through an

ammeter, Fig. 2, the current flowing in this short-circuiting cable and the potential being known, it is easy to determine what the flow of current is in the pipe when the shunt of known resistance has been placed around the pipe, for the current will flow proportionately to the resistance of the two paths of the water pipe and the shunting cable.

The remedies applied are : first, to connect the rail to the water pipe at points where the pipe is positive to the rail ; second, to use feeders, preferably by connecting the pipe at this point directly back to the station. Another method is to take the current from the water mains through a dynamo whose potential is negatively lower than the rail-return dynamos. Or the return through the ground and water

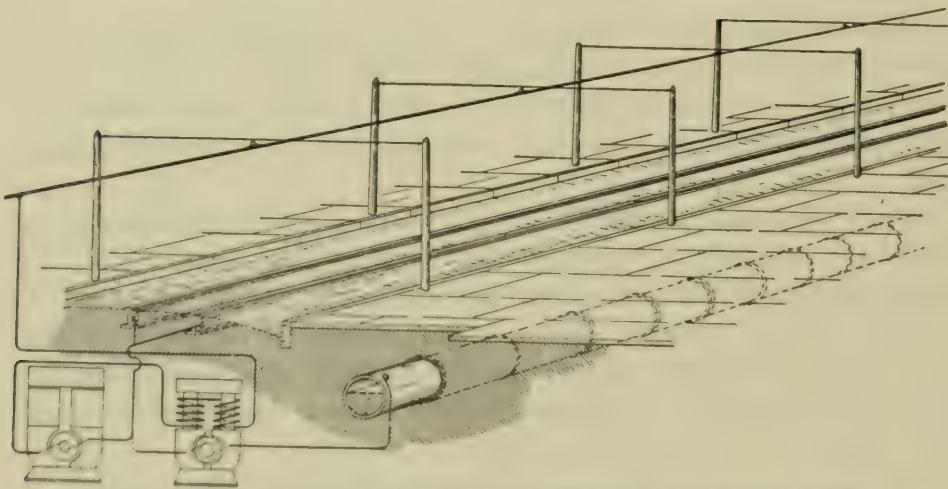


FIG. 3. METHOD OF CORRECTING ELECTROLYSIS IN WATER PIPES.

pipes may be fed through the armature of a low potential machine, keeping this system electrically negative to the rail, so that the current does not leave the water-pipe system, but naturally returns through this generator as the lowest potential point in the system, Fig. 3. The excellency of the bonding of the track and the proper placing of ground-return feeders is the most practicable and direct method of reducing electrolysis. If care and attention are given to these details, electrolysis can be reduced in most instances to a negligible quantity ; this can be assured also by a few subsidiary feeders connected to the water-pipe system.

Another interesting point is the question of the responsibility of railroad companies for depreciation of the water-pipe plant. As no one has a right to the earth or to earth return, the responsibility of the railroad company has yet to be defined. Electrolysis is characteristic in its action. It will pit and seam piping in a way that rust does not, and in lead pipe solvents are always present in large quan-

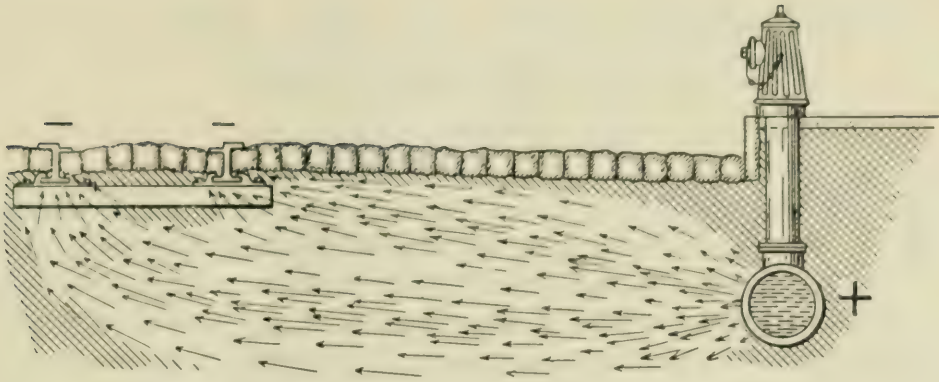


FIG. 4. A GRAPHIC EXAMPLE OF ELECTROLYSIS.

ties around or adhering to the pipe. Electrolysis in brass always eats it to needle points or knife edges. The soil through which the railroad and the pipes run has a great deal to do with the division of current between the two parallel circuits of water pipe and rails. Clay, as a rule, is the best insulator. Loam charged with salt water offers the lowest resistance. If loam or clay be charged with coal gas or sewer gas, the resistance is greatly reduced. Dry sand ranks next to clay as an insulator, and wet sand next to loam. Soil having water underlying it is always a low conductor; the current leaving the rail increases the capillary activity of the soil and draws water towards the rail. The rail positive to the soil is always moist.

THE IMPROVEMENT OF THE MISSISSIPPI RIVER BY DREDGING.

By H. St. L. Coppée.

THE practicability of improving the channel of the Mississippi river by dredging, and the relation of such improvement to the more permanent methods heretofore adopted, constitute a question not only worthy of discussion by engineers, but of interest to economists everywhere on account of the functions of the river as a great commercial highway and its important influence in problems of transportation affecting the world's supply of food and manufactured products.

After many years of study, experiment, and active construction, and the expenditure of millions of the public funds, the problem of the improvement of the Mississippi river is still in its infancy. More intimate acquaintance with the laws of its flow and power requires new departures in the general plan for the amelioration of its navigation. Dredging on a large scale, at first considered unnecessary, is one of these departures.

Heretofore the general plan of improvement has been practically the same from St. Louis to the mouth of the river, consisting in three distinct lines of procedure.

First, the contraction of the low-water flow to a normal width by means of lateral dykes and spurs, closing chutes, and auxiliary channels.

Second, the protection of the banks from abrasion and undermining by means of mattresses, submerged spurs, and other forms of revetment.

Third, the regulation of the high-water flow, thus keeping the thalweg as nearly as possible in the same relative position at all stages, by means of levees.

From St. Louis to Cairo, 180 miles, the work has been performed under the direction of engineer officers of the army, and paid for mainly out of funds appropriated specifically for that particular reach of river.

Since 1879 the improvement of the river from Cairo to New Orleans has been under the direction of a commission of seven members, men of national reputation and unquestionable engineering ability.

On the river below Cairo the work of permanent channel improvement, not including levee building, has been confined practically to two reaches, the principal harbors,—Hickman, Columbus, New

Madrid, Memphis, Helena, Greenville, Vicksburg, Natchez, and New Orleans,—and for the prevention of cut-offs, outlets, etc. Much of this work was necessarily experimental, and, though successful as a whole, has proven vastly more expensive than it was expected to be.

It has been demonstrated that this mighty river can be controlled and eventually trained between permanent banks without either raising its bed or destroying the great agricultural domain adjacent thereto, but this result can be obtained only by the expenditure of a large sum of money, far more than was at first deemed necessary,—a sum almost beyond the limit of obtainable public funds under the form of government and present status of public opinion in the United States.

It is now conceded by many engineers familiar with the problem that, in order to obtain the best results, the permanent work should commence at the head of the alluvial river and be extended down stream from year to year until the entire channel has been regulated, local works, which would ultimately form a part of the continuous system, being carried on for special purposes from time to time.

By a system of bank revetment or other protection commencing at the head of the alluvial basin is not meant a continuous revetment irrespective of general physical or topographical features; these, of course, will be potent factors in the problem, and will have to conform to certain limits, the river being allowed to cave at certain points until given degrees of curvature, slope, etc., obtain, and the effort being to obtain as great a length of river and as light a slope as possible, so that, when the bar building ceases, the conditions of depth and flow will conform more nearly to those existing below the mouth of the Red, where navigation is safe and permanent.

In order, therefore, to improve the river as a whole from Cairo to New Orleans, some caving bends would be passed by (though the general plan would be to protect each), and many isolated reaches would be revetted, irrespective of the continuous work.

In the present river, from Cairo to the mouth of the Red, there are about* 406 miles of caving bends. By making an allowance for additional caving produced by the new work, and eliminating the banks where protection may be unnecessary, the distance will not be materially changed. The cost, at the present rate for the most effective means of protection,—\$160,000 per mile,—would be, roughly estimated, \$67,000,000. Adding 10 per cent. for repairs and plant, the total cost of permanent bank protection becomes \$73,700,000.

With an appropriation of \$3,700,000 per year for twenty years,

* See report of Mississippi River Commission for 1896, page 3458.

this work might be accomplished, but it would necessitate the construction of about twenty miles of revetment each year, and involve great additional expense in procuring materials, such as brush and poles, that would have to be cultivated, or obtained at a great distance. In addition to the permanent work, the proposed dredging would cost in twenty years, in accordance with Colonel Henry Fladd's estimate for a channel 250 feet wide and 9 feet deep at low water from Cairo to Natchez, as follows:

For plant.....	\$1,188,000
Dredging.....	6,996,000
Total.....	\$8,184,000

Adding, as the amount necessary to perfect the levee system, \$20,000,000, we have the following approximate total for completing the improvement of the river from Cairo to the jetties:

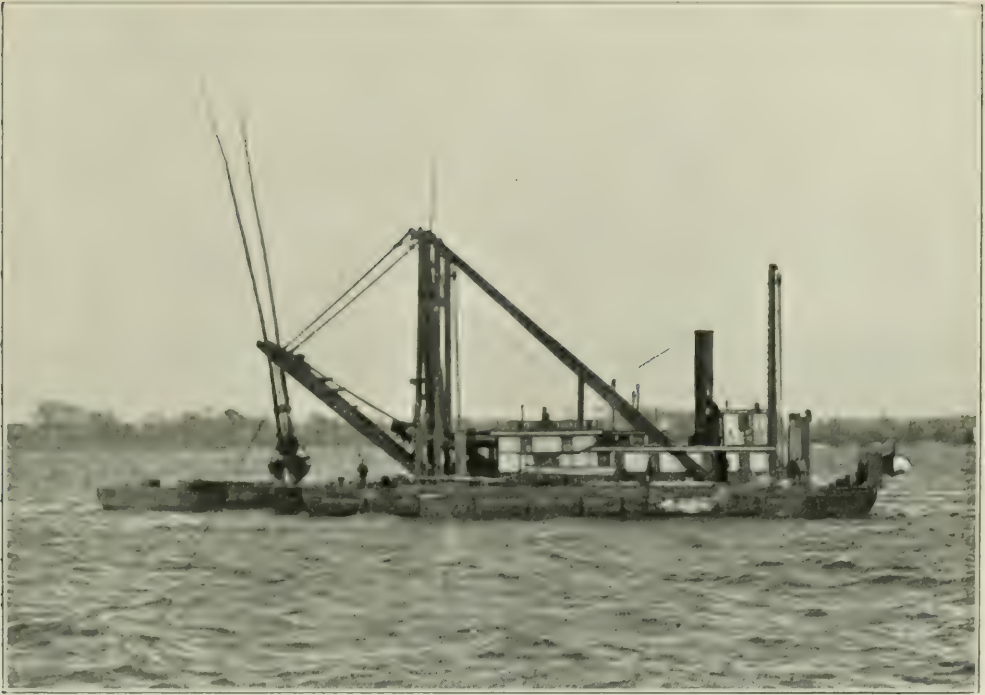
Permanent channel improvement.....	\$73,700,000
Levees.....	20,000,000
Dredging.....	8,184,000
Total.....	\$101,884,000

The fact will be appreciated at once that the obtaining of this vast sum in twenty years is, to say the least, doubtful.

In order to maintain a safe and paying navigation at all seasons, the plan of dredging the bars or shoals each low-water season and controlling the floods as far as possible with the funds allotted for that purpose has been adopted. The revetment to prevent cut-offs and outlets, and the maintenance of existing structures, are also parts of the general project, but continuous channel improvement, owing to the great cost, has been abandoned, at least temporarily, by the commission. Experiments are being made on a detached revetment or dike project designed by Colonel Amos Stickney, which, if successful, will revolutionize bank protection on the Mississippi river and bring the cost of permanent improvement well within the limit of obtainable public funds. It is only after many years of experience that it has been demonstrated that structures which control the flow in other streams are ineffective, or nearly so, in the Mississippi.

The methods adopted for permanent improvement, both high and low water—revetment dikes and levees—have been fully explained, in the past few years, in many reports and papers.*

* See Coppée on revetment, *Proceedings American Society of C. E.* and *ENGINEERING MAGAZINE*, June, 1896. Also Starling on Holland dikes.



A CLAM-SHELL DREDGE IN OPERATION.

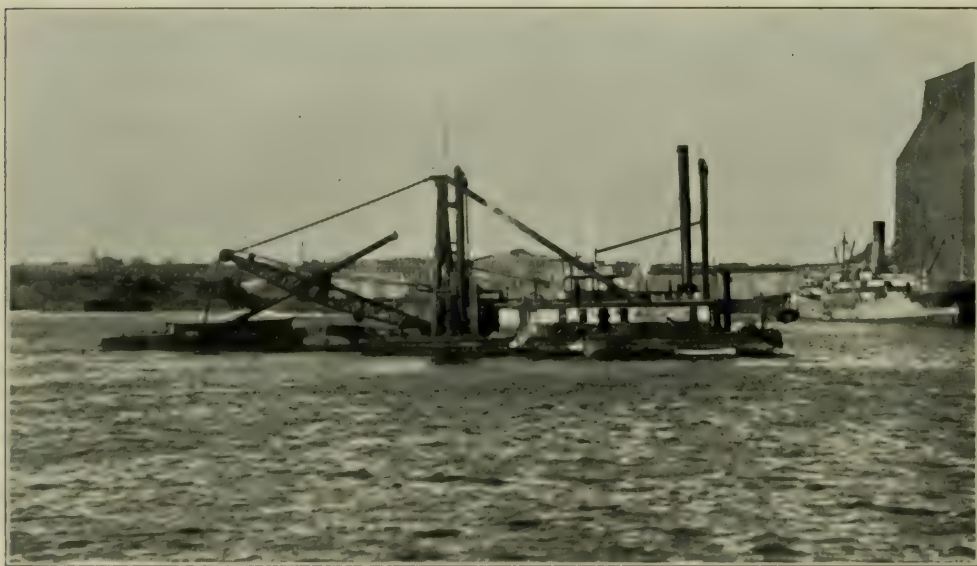
The bars obstructing navigation and necessitating the use of dredges are formed at high water; at low water the river is, to a certain degree, a series of pools and shoals. As the water falls below a half-stage plane, the shoal or bar is cut by one, or, oftener, more than one, channel, dividing the discharge of about 300,000 cubic feet per second at medium low water over a large cross-section and perhaps into numerous small chutes. The bars (also termed crossings), as they usually exist where the thalweg crosses from one side to the other, are generally composed of compact sand, sometimes mixed with gravel, and are about one hundred in number between St. Louis and Vicksburg. Some years the river does not reach a very low stage, and a depth of 8 feet or more is found on all the crossings. At very low stages the depth is reduced, in places, to 4 and even 3 feet. Nine feet is the greatest low-water depth which it is expected to maintain at first by the dredging operations.

Before excavating the bar, the purpose is to ascertain the locus and direction of the natural and deepest pass, and so deepen the bed in that direction as to concentrate the greatest flow into and through one well-defined steamboat channel. The first requisite is a thorough knowledge of the river in the vicinity of each crossing and of the bar itself, of the position of low-water channels and of the length of time they have maintained themselves in the past, and of the change taking place at present at all stages below moderately low water. In

order to obtain this knowledge, constant observations of depth, velocity, and direction of flow discharge, motion of sand (tailing of bar), etc., have to be made.

By commencing dredging operations on the most difficult crossings, before the river has declined sufficiently to impede navigation and while the velocity and scouring force of the current are still strong and actively at work defining the low-water bed, instead of waiting until the water is low and perhaps two or three subsidiary channels have formed, much advantage is gained.

It may be broadly stated that the dredge is used in nearly all river and harbor work of any magnitude in the world. In 1893, on



A DIPPER DREDGE AT WORK.

the Atlantic coast, seventy-five harbors were under improvement, sixty-six (88 per cent.) with the use of the dredge. On the Pacific coast of eleven harbors, six (54½ per cent.) required dredges. On the gulf coast all the harbors employed dredges, and on the great lakes about eighty-three (87 per cent.). On the inland rivers much the same practice is followed.

When the Mississippi river commission decided to employ dredges to improve low-water navigation, the first problem to be solved was that of the best form of dredge for the special duty of taking the sand from the crossings and moving it beyond the new channel quickly and economically. The dredges in use throughout the world were:

Scraper and sluicing dredges (including hydraulic and pneumatic sluices), dipper or scoop dredges, clamshell or grab dredges, bucket ladder or endless chain dredges, hydraulic dredges. Each of these types has numerous modifications to suit the special conditions and

purposes for which it is designed, differing in form of rake, jet, bucket, grab, hopper, machinery, hull, etc. In some there is a combination of two types, while in others the variation from the parent form is very marked, as in the pulsometer, pneumatic scraper, etc.

Scraper and jet dredges were generally used before the introduction of steam excavators, and were of a great variety,—rakes, harrows, plows, jet sluicers, propeller sluicers, etc.,—and even up to within a few years have been employed in this country and abroad. The principle on which they work is simply a scraping of the bottom by a directly-applied tool, or a water or compressed air jet, leaving the force of the current to carry off the loosened material. The great difficulty of applying this machine successfully to the bars of the Mississippi is that the crossings are invariably too long.

If, in a heavily-charged stream like the Mississippi, a scraper, jet, or propeller is worked, the first result is the lifting of the material from the bottom and its transportation for a short distance by the natural force of the water, aided by the accelerated velocity due to the propeller or jet. At a very limited distance this natural force and increased velocity is absorbed or overcome, and the water, containing an abnormal load, soon drops it, moving the dredged material but a short distance lower down stream. The successful dredging with this type of machine depends on the velocity, the weight and comminution of the particles of material, and the distance it is to be moved; also on the irregularity of flow, which produces boils and upward currents conducive to the support of the material in suspension.

In sedimentary streams very fine sand is carried in suspension near the bottom, but the coarse sand forming the bar is rarely found in motion, except in the form of a wave having a forward motion of translation and rotation. The Mississippi bars are formed of sand waves that constantly move down the river, with sharp down-stream slopes, inclining gently above. The height of these waves is from 2 to 8 feet, and the length from 100 to 500 feet.

It has been demonstrated by numerous trials of these scraper dredges, on the lower Mississippi, that the material is too heavy, the current too light, and the crossings too long, to obtain satisfactory, or even moderately durable, results. At the mouth of the river numerous forms were experimented with, but without success.

In a small pass near Vicksburg the writer used one of the large hydraulic graders as a sluice dredger with poor results. Near St. Louis, in September, 1882, water jets were tried, and fairly good, but temporary, results were obtained. Four pile-drivers, containing pumping apparatus for jet driving, were lashed together, and, by means of lines to anchors, were drawn across the bar. A single jet was formed

by fastening the four jet pipes together and directing the streams forced through them against the bar. About 165 gallons of water per minute were discharged, and the depth of six feet was increased, for a good navigable width, to $8\frac{1}{2}$ feet in 24 hours, but the depth was not permanent. In 1896 a jet dredge designed by Major Handbury was used on the river between St. Louis and Cairo at a number of shoals, deepening the channel from 1 to 3 feet. The plate on the opposite page shows the general arrangement of machinery, dimensions of centrifugal pump, and other details of the dredge.

The scoop or dipper dredge, one of the most extensively used American designs, is always employed in connection with scows or other auxiliary conveyors. In wide roadsteads tugs or tow boats handle the scows. The larger scows, having a capacity of 500 cubic yards, draw, when loaded, 8 to 10 feet. Their use on our shoal bars would be prohibitory, therefore, unless moored behind or directly in the cut, with a constant probability of grounding. The larger scoop dredges have a capacity of more than 3,000 cubic yards per 24 hours, in good material, allowing for lost time due to breakdowns, handling scows, etc. (about 30 per cent. of the engine hours). The scoop dredge cannot be economically used with attached conveyors or hydraulic discharge. In coarse sand its capacity is reduced, owing to the impossibility of obtaining a well-filled bucket. Very large machines of this type would not be economical on a Mississippi river crossing.

The writer's experience with clamshell dredges in sand on the Mississippi is that on a compact bar their capacity is reduced over half, notwithstanding the application of teeth attachments and other contrivances to facilitate the penetration of the leaves of the bucket.

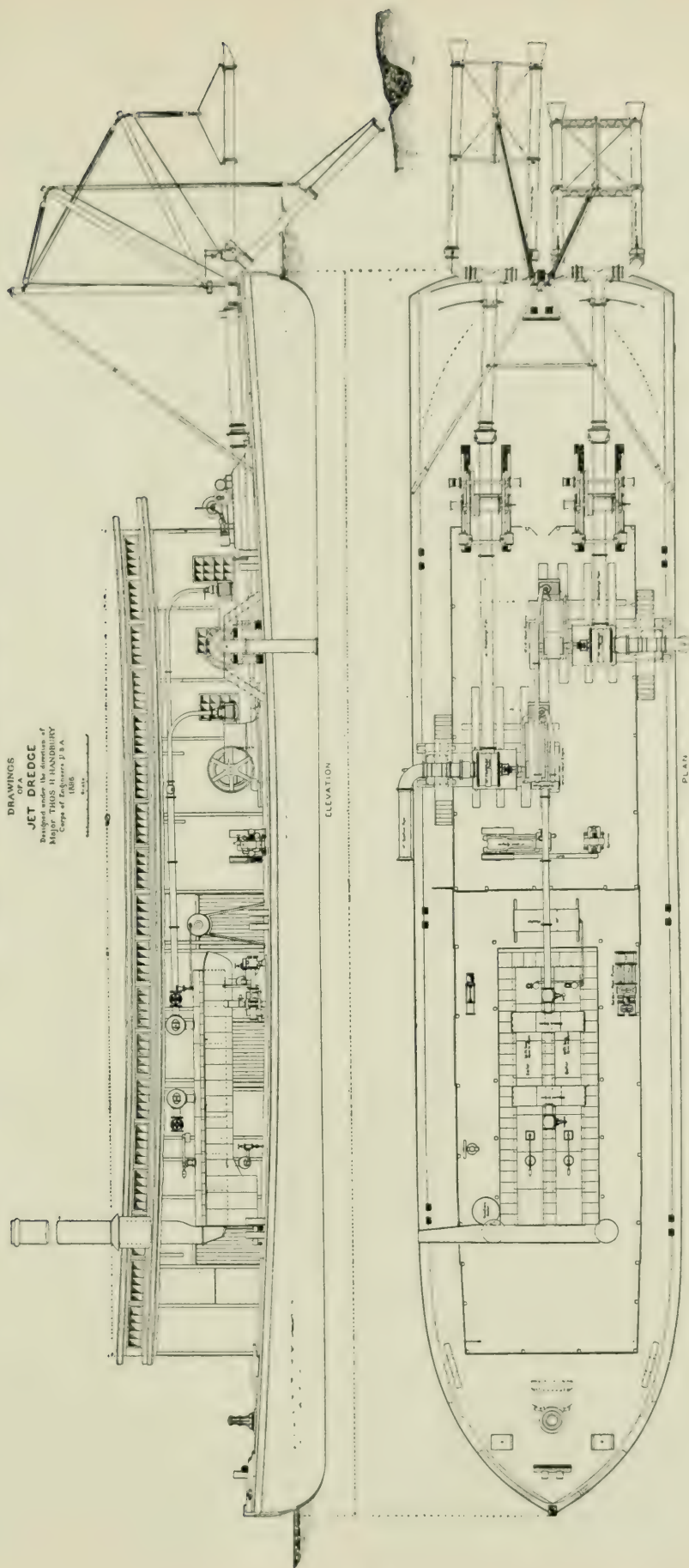
Near Vicksburg, in soft material, four-yard bucket machines moved about 3,000 cubic yards per 24 hours, digging in 40 feet of water,—not half of that amount when compact sand was encountered.

Like the scoop, this dredge requires the use of scows, and cannot be economically handled with attached conveyors. The loss of time due to repairs, handling scows, etc., is the same. Increased size of bucket and power of machinery adds little to its efficiency or economy, and for the purpose of dredging the Mississippi crossings it would give but mediocre results.

In the endless chain or bucket ladder machine much the same faults obtain. Bucket ladder dredges with self-contained hoppers are out of the question in this shoal river. Conveyors are successfully attached to these machines, and could be arranged on pontoons diminishing in height, but the distance of gravity conveyance would necessarily be small. The bucket ladder dredge used by the writer on

Improving MISSISSIPPI RIVER between mouth of Ohio and MISSOURI RIVER

DRAWINGS
OF A
JET DREDGE
Designed by
Major THOS. H. HANDBURY
Corps of Engineers, U. S. A.
1886



PLAN AND SECTION OF A JET DREDGE FOR THE MISSISSIPPI RIVER IMPROVEMENT.
Designed by Major Thos. H. Handbury, Corps of Engineers, U. S. A.

the Mississippi, like the single bucket machines, did considerably less work on encountering sand, possibly because of faulty construction of the particular machine used. This type of dredge could be used on the Mississippi bars, as it is in other portions of the world, in connection with a hydraulic conveyor, but it would not be as economical as the pump dredge, owing to the waste of power in raising to the top of the ladder material needed only at the elevation of the discharge hopper on deck. Webster says that the horse power required to raise the same material varies with the square root of the height from top of tumbler to surface of cut. The additional force exerted in a 300 yard-per-hour machine would be, therefore, about 15 h. p.

The difficulty of applying economically the above-mentioned dredges on the bars of the Mississippi lies not so much in their inade-

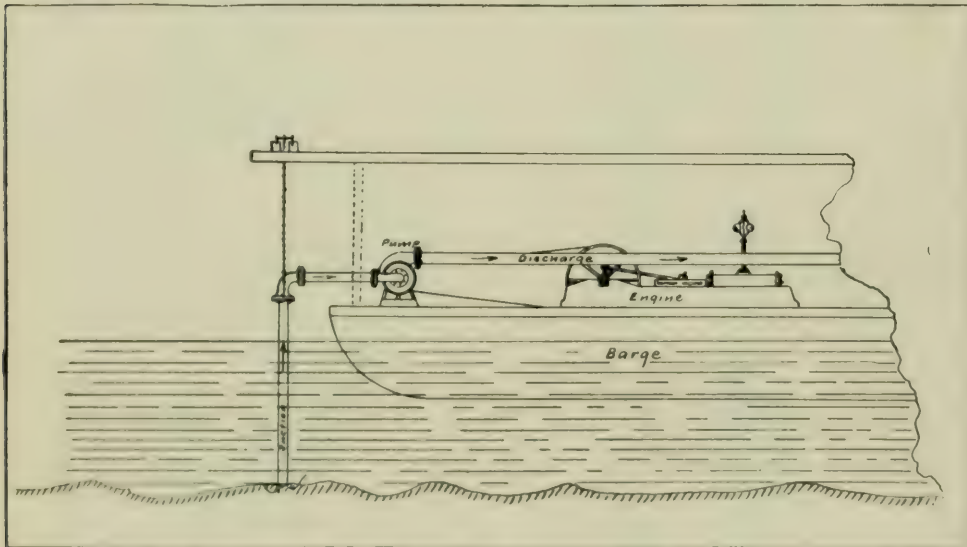


FIG. 1. SIMPLE FORM OF HYDRAULIC DREDGE.

quate excavating power as in the means of conveying the dredged material the necessary distance from the dredged channel. The real problem to be solved, therefore, is not alone that of excavation, but that of conveying the dredgings in this wide river subject to so numerous varying currents and strong winds. That the last and more modern type of dredge is better fitted for this work is self-evident. The reduction in lift and economy in operation on a large scale can not be doubted. Its double function of conveying as well as excavating fits it especially to this particular project.

The simplest form of the pump or hydraulic dredge is shown in Figure 1. Here we have a small centrifugal pump run by a belt from a small engine, a suction pipe of iron and rubber, and the discharge. When the pump is in action, the water and sand are drawn from the bottom, pass through the pump, and are forced through the discharge-

opening to a distance governed by the length of pipe, power of engine, capacity of pump, height of dumping ground, etc. The centrifugal pump differs from the ordinary reciprocating pump in that it is valveless and can take up and discharge large quantities of water containing large percentages of foreign matter without detriment to its parts. It consists of an iron shell or box, through which a shaft works; on this shaft and in the shell is a runner with blades, fixed or adjustable, forming a species of fan. On the shaft outside of the shell is a pinion or gear, by which connection is made with the engine. The water and material is taken into the pump at base or center of the fan wheel, and discharged at right angles to the suction and at the outer edges of the blades.

These pumps are made of various patterns, sizes, and capacities. One lately designed for the partial drainage of New Orleans is nearly 12 feet in diameter, and has a capacity of 1,900 cubic feet per minute.

It is claimed that Bamath, Hoffman & Schwartzkopf, a German firm, first patented the hydraulic dredge in 1856. Mr. Bowers, of California dredging fame, was also a pioneer in hydraulic dredging, but probably the first extensive application of the pump for transporting dredged material was as recent as 1867, on the Grand Canal at Amsterdam, the capacity of the pump being 1,330 yards per twelve hours, conveyed 900 feet and lifted 5 feet.

In 1872 General Gilmore, of the United States Engineer Corps, operated a crude suction dredge at the mouth of the St. John river, Florida, which moved 78 cubic yards per hour at a cost of about 31 cents per yard. In 1877 Captain Eads designed a hydraulic dredge, which worked at the mouth of the Mississippi. The Van Schmidt dredge of 1883 was the first complete hydraulic machine of large capacity and delivering design used in this country, and is a good illustration of the truth that "necessity is the mother of invention."

From these beginnings in the near past have been evolved the great hydraulic dredges, too numerous to mention, that have developed enormous capacity for excavation and delivery of material in sea, river, and canal, of various forms, from the stationary pulso-meter used on the Potomac flats to the sea-going hopper dredge with mammoth rotary pumps, each varying in general design and detail with the conditions under which they operate.

The principles involved and the general mechanical design have varied but little in the hydraulic dredge. Changes in form of cutter or jet, position of machinery, and strength of material of construction have been made, but the great difference is in the enormous increase in size, capacity, and conveying power. Compare the 1,250 yards of

the Van Schmidt dredge of 1883 with the hopper pump dredge Brancker which, on the Mersey bar, in December, 1893, moved more than 22,000 tons (about 13,000 cubic yards) of sand per day.

All over the world, where sand is to be excavated under water in large quantities and delivered from a half mile to ten miles or more, the hydraulic dredge is coming into use, either in the form of direct hydraulic force delivery dredges or hopper dredges with self-propelling machinery for transport to distant dumping-ground.

To move vast quantities of sand in a short time and deliver it from one thousand to two thousand feet from the channel required a new departure. In 1894 and 1895 a dredge was constructed by the commission, which, though a success, was but the step to the great hydraulic machine which followed the next year and with its consort kept the river open to navigation during the low-water season of 1896. The first dredge was named the Alpha. It was designed, after careful experiment and investigation had demonstrated the proper dimensions, power, and capacity for its machinery and frame, and has proved a success, though of much less capacity than the later dredge, Beta, which is probably the largest and most complete hydraulic excavator in the world to-day. The dredge Alpha at work is shown on page 469. The plant accompanying this dredge consists of one large steam tow boat, one pile-driver, and three barges. Her working force, including that of pile-driver and tow boat and survey party, is as follows :

Assistant engineer.....	1	Oilers.....	2
Master.....	2	Deckhands.....	8
Mates.....	2	Stewards.....	1
Steam engineers.....	4	Cooks.....	3
Master laborers.....	3	Waiters.....	3
Machinists.....	1	Laundresses.....	2
Carpenters.....	1	Surveyors.....	1
Strikers.....	2	Laborers.....	16
Firemen.....	6	Rodmen.....	1
Watchmen.....	2		

The report of her operations during the season of 1896 gives the cost of material (sand and gravel) moved as 4.3 cents to 12.1 cents per yard, the latter due to breakdown in runner of main pump.

At one crossing, Compromise Bar, 77 miles below Cairo, the work consisted of 7 cuts, aggregating 5,405 lineal feet, the dredging time being $257\frac{1}{4}$ hours, and the average rate 21 lineal feet per hour. The amount of material moved was 80,555 cubic yards,— $312\frac{1}{2}$ cubic yards per hour. The cost was \$3,473.68; average cost per cubic yard, 4.3 cents (sand and gravel).



U. S. DREDGE "ALPHA" AT WORK ON OSCEOLA BAR.

The Beta, though similar in general conception to other hydraulic dredges of the day, differs much in size and detail. Strictly speaking, it consists of two separate dredges on one hull, each with cutters and suction openings leading to a separate suction, large centrifugal pump, and discharge. The hull is of steel, 172 feet long, 40 feet broad, and from 7 feet 2 inches to 10 feet 10 inches in depth. About midship of the hull are located the two centrifugal pumps, one on each side, each, as stated, acting as a separate and complete hydraulic dredger. Each pump has a runner 7 feet in diameter and shaft 10 inches in diameter, with discharge 33 inches and suction $33\frac{3}{4}$ inches in diameter, actuated by separate triple-expansion engines with high-pressure cylinders $20\frac{1}{2}$ inches, intermediate 33 inches, and low-pressure 38 inches in diameter, with 24-inch stroke. Each engine has jet condensers. Steam is obtained from four 375-h. p. Heine boilers, placed as shown in the drawing.

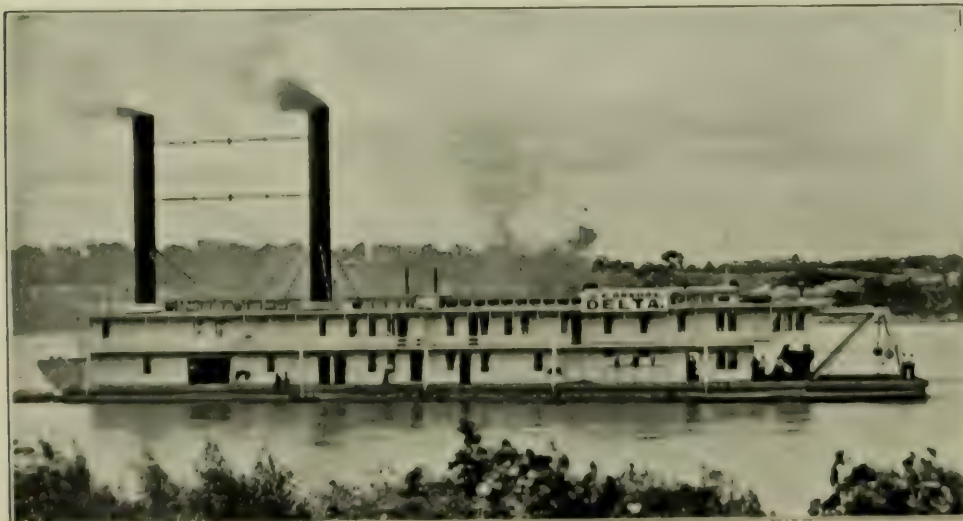
The six suctions, three to each main suction pipe, are $19\frac{1}{2}$ inches in diameter. At the end of each suction pipe there is a revolving cylindrical cutter 5 feet in diameter, which cuts up the material to be inhaled by the great pumps. Each suction pipe is partially buoyed by a pontoon. The cutters are actuated by a small engine placed at the extreme bow of the dredge, which gives the cutters a speed of 25 revolutions per minute. The average speed of the centrifugal pumps, while working, is from 125 to 130 revolutions per minute.



U. S. DREDGE "BETA" BEFORE HER OFFICIAL TESTS.

The machinery for hoisting the suctions and cutters and regulating the movements of the dredge is shown just aft of the cutter engines.

Two vertical spuds for holding the dredge in place, and one pushing spud, are situated astern, and are moved by a small three-drum hoisting engine. The discharge or pipe conveyor is about 1,000 feet long, extending from the stern of the dredge to the dumping-ground. It consists of 50-foot lengths of $33\frac{1}{2}$ -inch steel pipe, resting on steel pontoons; the pipes have rubber hose connections, and are also connected and held in place by steel bars. When the dredge is operating, the pontoons are almost completely submerged. The power generated by the machinery on this dredge is more than 2,500 h. p.,



U. S. DREDGE "DELTA."



U. S. DREDGE "GAMMA" UNDERGOING EFFICIENCY TESTS.

and her weight is more than 1,000 tons. An electric plant of two 4,000-c. p. search lights and forty 20-c. p. incandescent lights enables the dredge to be worked continuously at night. The dredge has a traveling crane, blacksmith shop, and all the outfit required to work at a distance from point of supply.

The following is the manner of operating. After being placed at upper or lower edge of the crossing by her attendant steamboat, her spuds and cutters are lowered to hold her in place. Two clusters of piles are then sunk up stream on the line of proposed dredging extended, and cables are run from these piles to drums on the dredges. Piles are then sunk for guiding the line of discharge-piping and keeping the dump well removed from the cut. When these operations are completed, the dredge is ready for work; the spuds are raised, the suctions with cutters adjusted to the required depth, and the pumps and cutter engines started, the dredge being either

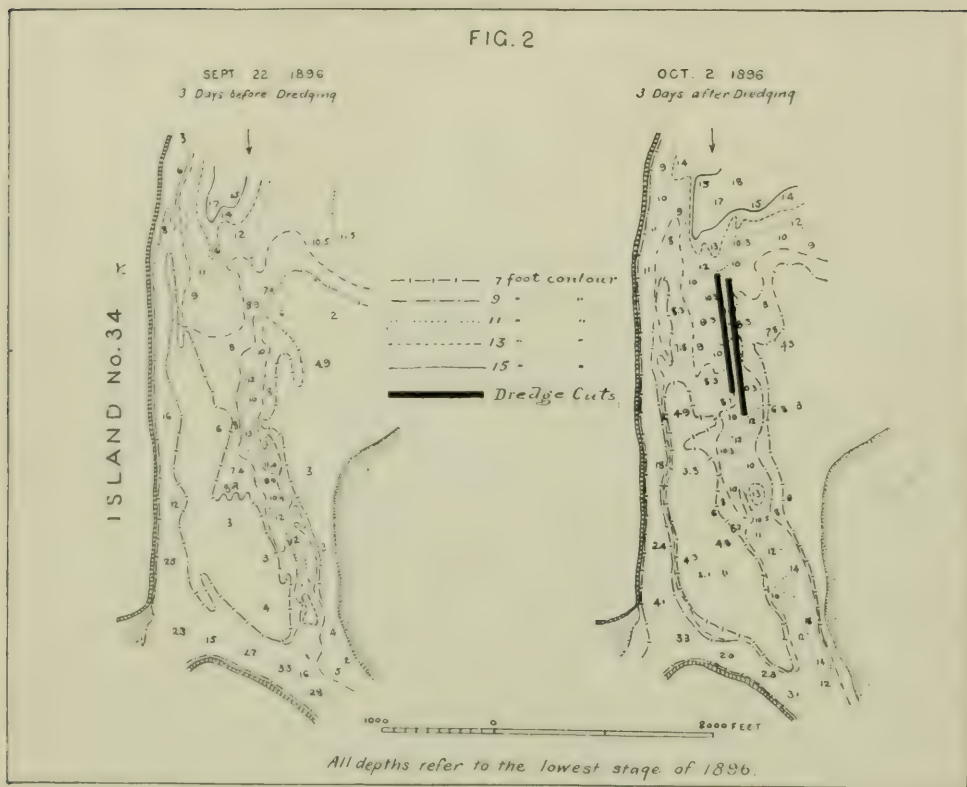


FIG. 2. THE IMMEDIATE RESULT OF DREDGING AT ISLAND 34.

dropped backward over the bar by rendering the cables or moved forward by means of the engines near the bow. The best method seems to be pulling up over one cut and dropping over the next, and so on, thus economizing time and obtaining the best results.

As the centrifugal force and reaction in the long line of discharge-pipe tends to give a forward and transverse motion to the entire attached floating plant when operating, a baffle plate is used at the end of the line of discharge to counteract this tendency.

The results of the first tests of this dredge were very astonishing and misleading. The average working capacity proved to be much lower than that which the short-time trials of the contractor had given reason to expect; yet it was far above the working capacity of other hydraulic dredges in the country.

The contractor's tests, which extended over less than ten minutes of actual operation, showed an average velocity of discharge exceeding 13 feet per second, a percentage of solids to gross discharge of 23, and a delivery of 4,921 cubic yards of sand per hour.

The plant for this dredge consists of two steam tow boats, one quarter boat, one machine shop, one pile-driver, and two barges.

During the season of 1896 this dredge was employed on seven

**SUMMARY OF DREDGING OPERATIONS, DREDGE BETA, MISSISSIPPI RIVER, BETWEEN CAIRO AND MEMPHIS,
DURING LOW-WATER SEASON OF 1896.**

Place and Date.	Cuts.				Average Depth. in feet.				Heads in feet.		Revs. Av. per Min.		Distribution of time by hours.								Material Moved.				
	Number.	Total Length Feet.	Time Required Hours.	Rate ft. per Hour.	Suction.	Ahead of Dredge.	Astern of Dredge.	Material Removed.	Suction.	Delivery.	Pumps.	Cutter Engines.	Steam Pressure.	Placing Plant.	Dredging.	Changing Cuts.	Repairs.	Passing Boats.	Making up tow.	Towing.	Sundays and Holi- days.	Total Time.	Dimensions of Sur- ficial Area feet.	Cu. Yards.	Cost per cu. yd.
Island No. 40, (211, L.) Aug. 31, to Sept. 24, 1896.*	10	5,945	121.0	49.1	15.3	9.2	13.4	4.2	14.4	19.1	129	120	161	53.5	121.0	25.2	12.7	1.0	39.0	104.0	19.0	375.5	800X2000	176,370	3.5
Island No. 34, (179, R.) Sept. 25 to 30, 1896.	3	2,265	66.0	34.3	15.6	9.5	13.5	4.0	15.2	21.6	134	125	165	16.5	66.0	5.0	11.5	6.5	25.5			134.0	800X2200	91,852	2.0
Osceola Bar, (164.5, R.) Sept. 30 to Oct. 9, 1896.	9	5,660	63.7	89.0	15.0	9.4	13.5	4.1	15.2	20.8	135	119	167	11.0	63.7	7.7	6.5	20.5	97.5	10.0	217.0	800X2300	65,555	3.0	
Hathaway's Lower Crossing, (102, L.) Oct. 9 to 15, 1896.	16	1,2175	87.0	140.0	20.5	14.8	18.7	3.8	15.0	23.4	134	132	160	23.0	87.0			5.5	28.0			143.5	800X2400	80,502	2.0
Cherokee Crossing, (89 R.) Second time. Oct. 15, to 24, 1896.	11	6,435	78.2	82.3	17.0	10.8	15.8	5.0	14.5	24.5	135	129	163	9.5	78.2		9.7	18.0	24.0			139.5	800X2500	62,000	2.8
Lower Point Pleas- ant, Mo., (79. 5, R.) Oct. 25 to Nov. 3, 1896.	13	9,415	109.2	86.2	16.0	7.7	13.5	5.8	15.2	25.6	136	131	162	13.0	109.2	6.7		7.0	24.0	24.0	24.0	240.0	800X2100	82,870	2.8
Cherokee Crossing, (89, R.) Third time. Nov. 4, to 13, 1896.	10	8,980	175.0	51.3	17.3	10.7	16.1	5.4	13.6	25.9	137	113	164	14.0	175.0	24.0		24.0		3.0		240.0	800X3000	128,148	2.4

* Capsizing of pipes delayed the work 22½ hours.

crossings; her record on one near Island No. 34, 179 miles below Cairo, was as follows. Two cuts were made nearly parallel, 40 feet apart, aggregating in length 2,275 feet; the time for dredging was 66 hours. More than half the work was done without the use of the cutters, the material being sucked up without previous agitation. The rate of advance was 24 feet per hour. The material was coarse sand and gravel. The suctions lowered to a depth of $15\frac{1}{2}$ feet. The number of cubic yards moved was 91,852,—an average of 1,392 yards per hour. The total work, including towing, cost \$1,793.42, or 2 cents per yard.

Figure 2 shows the channel at Island No. 34 three days before and three days after dredging. Sixty days later the depths on the crossing were less than they were before dredging, because of a wrong location of the cuts and repeated oscillation of the water surface in a short time. The diagram shows only the immediate effect of dredging. At points where the cuts were made in the natural channel, and not at variance with the direction of flow, the work was successful.

Table 1 shows a summary of the operation of this dredge during the low-water season of 1896.

The percentage of solids to total discharge during the season was about 12. On one crossing this dredge used $89\frac{1}{2}$ bushels of coal per hour. The cost of dredging throughout the season was about $2\frac{3}{4}$ cents per yard of sand moved.

In addition to the two dredges mentioned, two more are completed and at work,—the Gamma and Delta,—and two more are under construction,—the Epsilon and Zeta. The Gamma has two suctions with jet agitators, her capacity being 800 cubic yards per hour. The Delta has mechanical agitators. The capacity of the Epsilon and Zeta is supposed to be 1,000 yards per hour, the former using jet, and the latter mechanical, agitators.

For work between the mouth of the Missouri and Ohio two more steel hull dredges, with water-jet agitators, are being constructed from Major Handbury's designs.

I desire to acknowledge the kindness of Mr. Ellis Thompson, United States assistant engineer, and Captain H. E. Waterman, secretary of the Mississippi river commission, in obtaining for me the photographs with which to illustrate this article.

REVIEW OF THE ENGINEERING PRESS

The Niagara Railway Arch.

ALTHOUGH much has already appeared in print about the new steel arch bridge over the gorge at Niagara, what may properly be called the official account has just appeared in the *Proceedings of the American Society of Civil Engineers* in the form of a paper by the resident engineer in charge, Mr. R. S. Buck.

Much of the interest in this work is due to the location, while the fact that the new bridge replaces the famous suspension bridge of Roebling, so long a feature of the view at Niagara Falls, has also added to the note of the structure. The old bridge, which had been standing 42 years at the time of its removal, had been repaired and strengthened several times, until nothing was left of the original structure but the cables, saddles, suspenders, and anchorages.

The new bridge is a two-hinged, spandrel-braced arch, of 550 feet clear span, there being no hinge at the crown, and it was built on exactly the same site as the old suspension bridge without interrupting travel. It was this question of erection which constituted the characteristic feature of the work and some account of it will be of interest.

"The deflection of the old bridge under moving load, the constant passing of trains, and the scant clearances at many points were considerations demanding close and constant attention; but as each difficulty was reached, it usually lost much of its formidable aspect. Besides, there was the comforting assurance that what had been accomplished with the old bridge under considerably less favorable circumstances ought to be accomplished again.

"Briefly, the principle of erection was to build out the two halves of the arch as cantilevers, anchored to the solid rock on top of the bluff, by means of adjustable anchor chains connecting with the arch at the top of the end post.

The anchor chains consisted of the top chords of the end spans, such of the eye-bars of the end spans as were adapted to the purpose, and such additional eye-bars and slabs as were necessary to complete the connections. The slabs were used as a matter of economy to serve as short eye-bars. The anchor pits were cut into the solid rock, back near the anchor walls of the old bridge. They are shafts 3 feet by 6 feet in section, and 19½ feet deep. Chambers were excavated at the bottom of sufficient size to admit the anchors. After the anchors, and the first two sections of the anchorage chain were placed, the anchor pits were filled with concrete to the top of the rock."

An adjusting toggle, operated by right and left hand screws was used and was found very effective in lifting and lowering the load in order to make the necessary adjustments.

It was originally intended to use an overhead cableway to convey and place the material, but owing to the large cost of a plant suitable for handling heavy and unwieldy pieces, travelers resting on the top chords of the arch were substituted. This erecting plant proved very safe and efficient. The two sides were entirely independent of each other, furnishing two points of progress, and when there was no outside cause of delay, the erection proceeded rapidly.

The material was conveyed to the travelers by means of trucks running on each side of the bridge. These tracks rested on the false work as far out as the end posts of the arch span, and from there to the center on the sidewalk brackets.

The erection proceeded from both sides to the center, and as the closure at the middle was reached some anxiety was felt, as the absence of a center hinge made much depend upon the accuracy of the workmanship. The distance was checked as closely as practicable when the half-spans were partly completed, and when

the center panels were placed there remained a space of 8 inches due to the extent to which the two halves of the arch had been drawn back to secure the necessary clearance for the placing of the final panels. The anchorages were then gradually slackened and the two halves of the arch allowed to come together.

Contrary to intention, the ribs met before the top chords, and hence the latter did not receive the compression for which they were intended, and it became necessary to force the top chords apart at the centre and insert shims, which was done without serious difficulty. The floor system was then raised to its proper position, and the removal of the old work and the placing of the new was done between trains, two panels at a time.

The completed work was tested by using two test trains as heavy as available, this amounting to 3500 lbs. of live load on each track per running foot, and the deflections observed were entirely satisfactory.

The manner in which the work was done is admirably illustrated in Mr. Buck's paper, both with photographs of the partially executed work and of the finished bridge, as well as strain diagrams and deflections, and the whole forms a valuable record of a noteworthy example of bridge construction.

Pig Iron Analyses.

THE use of chemical analysis in the iron and steel industries has proved of such practical importance that the work of the chemist has been extended to the analysis of pig irons for foundry use, and in a paper read before the Pittsburgh Foundrymen's Association Mr. Thos. D. West discusses the subject in a very practical manner, showing the conditions under which the work of the chemist should be used in connection with foundry practice.

Some of the difficulties with which foundrymen have had to contend are very forcibly presented in Mr. West's paper.

"While the past four years have witnessed a greater revolution in foundry practice than any like period, methods of making mixtures were never in the plight

in which we find them to-day. The recent introduction of chemistry in founding has brought a realization of the impossibility of accurately judging the grade of an iron from its fracture; yet there is still a prejudice with many against chemical analysis as a determiner of grades for making mixtures. It is unfortunate that there are features involved in such analyses that give the opponents of chemistry some ground for throwing doubt upon it. All improvements have to combat with more or less prejudice and difficulty before they can establish themselves. For this reason those who know from experience the value of working by chemical analyses should not be discouraged or sit still and let the retarding influences have full sway. The thing to do is to determine the factors that tend to prevent the general use of chemical analyses, and work to correct what needs correcting."

Among the points which Mr. West cites as tending to retard the introduction of the chemical method of determining the use of irons in mixtures are included: the absence in the use of uniform methods of analysis; the length of time which often elapses before the results of the examination of a given sample are returned; and the absence of any method of standardizing the drillings which are sent as samples.

By giving a number of tables of comparative results of analyses of drillings taken from the same pieces of pig iron, the differences between the results of the various chemists is clearly shown. "Considering that the drillings were taken from pig metal, which is not as good for checking purposes as clean especially prepared solid castings, and that there is no uniformity of method in analyses at the present time, the close results seen in the table are very creditable to the various chemists, and demonstrate that great care was exercised by all."

At the same time there were variations of sufficient importance to affect the results to a marked degree had these analyses been used for the purpose of making mixtures for actual foundry use. "When such differences are found in analyzing

pig metal where the greatest care and skill has been exercised, what are the chances to be run in accepting analyses made by the different rapid methods in the rush of every day furnace practice? Here we have, with the best of care and skill, a variation in the ingredient mainly due to lack of uniformity in laboratory methods and of a standard for analyses sufficient to affect two-thirds of all the castings made, causing them to be either bad, or ill-suited for the use for which they were intended."

The remedy for this state of affairs, in Mr. West's opinion, lies in the standardizing of methods not only of analyses but also of selecting drillings for samples. The idea of a central testing laboratory for standardizing laboratory work for furnace work and iron founding is suggested, and the usefulness of such an institution situated in the center of the Pittsburg district cannot be doubted, although certain practical difficulties in connection with its use can be foreseen.

Mr. West has certainly done well to call attention to this subject and it is to be hoped that his paper and the discussion which it has aroused may be the means both of securing more uniform and reliable analyses and of extending the chemical method of determining the suitability of various irons for practical purposes.

The History of the Stone Arch.

A VERY interesting historical sketch of the development of the stone arch, especially as applied to engineering work, is given in a paper by Professor Malverd A. Howe, read before the Engineers' Club of St. Louis, and published in the *Journal of the Association of Engineering Societies*.

Professor Howe rightly goes back of the once accepted idea that the Romans were the originators of the true arch, and shows conclusively that although many of the so-called arches of earlier times were really composed of horizontal layers, corbelled out, beehive fashion, with the faces dressed off to the intrados curve, yet there were true arches with radial joints known to the Egyptians, as well as the Assyrians, although neither of these nations, nor the Greeks appear to have trusted the arch

sufficiently to use it in any works of magnitude that have come down to us.

"All records in the form of ruins, tablets, etc., fail to indicate that the true arch was employed in structures to any great extent prior to the sixth century B. C. The arched form, however, was quite common from earliest times, and ruins have been found in all portions of the world. There are a large number of examples of the true arch in bridge construction in China, as well as the primitive form of stone bridges without arches. The dates at which these bridges were constructed is unknown, but many believe that the Chinese built the true arch long before it was known to the western world."

"To the Romans we are indebted for the almost universal use of the voussoired semi-circular arch in bridge construction. From the second century B. C. until the fourth century A. D. the Romans built many magnificent stone arch bridges for roads and aqueducts, the magnitude of which has not since been equalled."

From a list of the principal works of this character it appears that between 312 B. C. and 226 A. D., sixty-three miles of arch bridges were built. An interesting fact in connection with the Roman bridges is that the centering was almost always supported upon large stones projecting from the piers below the springing line, as is still clearly shown in the cases of the aqueduct of the Pont du Gard near Nimes, in France, and in the aqueduct bridge near Segovia, in Spain.

Pointed arches for bridges came into use in mediæval times, as the Gothic arch developed in building construction, and one of the famous bridges of this type is the old bridge at Avignon, built by St. Benezet, of whom several variations of a miraculous legend are related in connection with the work, and throughout the middle ages the "Brothers of the Bridge" formed a semi-ecclesiastical, semi-industrial order by whom many important works were constructed.

The important arches of modern times are enumerated at some length in Professor Howe's paper, and much interesting information is given from various sources,

although as he truly says: "Data concerning even the more modern structures are very hard to obtain, and in many cases it is practically impossible to purchase photographs."

In conclusion the following general points are made:

The Romans first used the arch in the construction of bridges in the second century B. C.

Until about the thirteenth century the arch in bridges was of the circular form, and almost without exception it was semi-circular.

The pointed arch was first employed in bridges about the thirteenth century.

In the fourteenth century segmental and elliptical arches were introduced.

At the present time the segmental arch is almost universally employed for long spans.

The Progress of Metallography.

WHEN a science makes such progress that it can furnish enough material to maintain a special publication devoted to the advancement of its interests, it is entitled to especial notice and demands a frequent hearing.

The science of metallography, or the study of metals through their physics and microstructure has become such an important feature in the art of testing that Mr. Albert Sauveur, of Boston, has undertaken the publication of a quarterly journal, entitled the *Metallographist*, devoted to the study of metals with especial reference to their physics and microstructures, and from the two numbers which have already appeared there seems to be no doubt either of the field for such a journal or of the ability of Mr. Sauveur and the colleagues associated with him to occupy it.

With but few exceptions, the most active workers in the field of metallography have been in Europe, rather than in America, and hence it is not surprising to find many of the papers in the *Metallographist* are translations of the memoirs and papers of such investigators as Osmond, Ledebur, Le Chatelier, Charpy, and Jüptner von Jonsdorff, but England

and America are also represented by the names of Hadfield, Saniter, Roberts-Austen, Howe, Colby, and others; and if the high standard of the early issues of the quarterly is maintained by subsequent contributions and reprints from these and other writers of equal reputation the science of metallography will surely be well presented.

In his prefatory remarks, introducing the new review, Mr. Sauveur shows how important a thorough knowledge of the structure and behavior of metals is to the practical side of engineering work, and how investigations which at first seem to have but a laboratory interest may lead to most valuable results in practical engineering.

"The word metal at once suggests strength, solidity, durability, efficiency, usefulness, trustworthiness. As pure as gold, as true as steel, are well earned testimonies. An iron will stands for a will that does not falter. Reliability is perhaps the quality of metals which should most endear them to us. From the knowledge that they will not fail us we derive a feeling of security, which leads us daily to intrust our lives to their stanch qualities, be it in our fast-moving trains, over our frail-looking bridges, in the vicinity of boilers and fly-wheels, or on the twentieth story of one of our modern buildings. And if rails and axles do occasionally break, if bridges and buildings occasionally collapse, if steam boilers explode, if a fly-wheel sometimes goes to pieces, could we only ascertain in every case the cause of the failure it would be invariably found that man, not the metal, was at fault. We should invariably discover that the failure was due to a faulty construction, to a defective process of manufacture, or to some injurious treatment of the finished product. We should find that man had violated some law of nature, which like all such transgressions, led to the inevitable penalty. Such instances of failures illustrate only more forcibly their wonderful efficiency, and the confidence which can be placed in metallic productions which have been created and erected in strict accordance with their chemical and phy-

sical properties and the general laws of nature."

At the present time there is an increasing activity in scientific metallurgical researches. "The metals and their alloys are being dissected, and the high-power objective, that wonderful instrument of research, is revealing to us their intimate structure, throwing a flood of light upon their constitution, chemical and physical, the practical as well as the theoretical value of which could hardly be overestimated. Their physics, hitherto much neglected, is being minutely investigated. Their thermal behaviour is being ascertained with a precision rendered possible only by the extremely delicate pyrometer of Le Chatelier. Their magnetic properties, their electric conductivity, their diffusion, their physical and mechanical properties in general are being investigated with a degree of accuracy never before attained. The chemist is energetically at work, in his endeavor to establish the true chemical relation between the metals and their impurities, and successful excursions are being taken in the domain of their proximate compositions.

As M. Osmond has aptly said, modern science is treating the industrial metal like a living organism, and we are led to study its anatomy, *i. e.*, its physical and chemical constitution; its biology, *i. e.*, the influence exerted upon its constitution by the various treatments, thermal and mechanical, to which the metal is lawfully subjected; and its pathology, *i. e.*, the action of impurities and defective treatments upon its normal constitution."

The Efficiency of Steam Jackets.

THE value of the steam jacket as a feature of steam economy has long been a question for discussion by mechanical engineers, and the transactions of engineering societies show the very decided and yet opposing views held by prominent members of the profession upon this subject.

Especially in connection with multiple-expansion engines has the economy effected by the steam jacket been a matter

for question, and, whenever tests could be so made as to add to the stock of information on this point, the results have been carefully examined and discussed.

The latest contribution to the data upon the economy of steam jacketing is found in the report of the test of the compound engine at the Grosvenor-Dale Mills, made by Mr. George H. Barrus, and reported in the *Engineering Record* with an editorial discussion.

According to Mr. Barrus's figures, the economy of steam due to the use of the jackets was about 2 per cent., including the reheating of the steam in the intermediate receiver.

"An economy of 2 per cent. in favor of jacketing and reheating is hardly worth considering, when we take into account the extra complication and possible increase in the danger of breakage which are incident to their use." By figuring the saving of 2 per cent. on the total fuel-consumption, and comparing the amount with the estimated cost of the jackets and receiver, the *Engineering Record* shows that the interest on the outlay practically equals the value saved by the performance, leaving no real gain, and, it may be added, this agrees well with results obtained elsewhere.

The behaviour of the jacket is interesting to consider. "If, in the recent tests, we analyze the diagrams and compare one set with the jackets in use with another set with the jackets not in use, it appears that there is a very marked difference, and that the failure of the jacket to show a greater advantage is not due by any means to inaction. The noticeable feature in the operation of the jacket is that it increases the work done by the low-pressure cylinder. In the two comparative trials the horse-power developed by the low-pressure cylinder with the jackets in use was 29 per cent. more than that developed by the high-pressure cylinder. When the jackets were shut off, the increase in the power developed by the low-pressure cylinder was only 7 per cent. of the power developed by the high-pressure cylinder. Furthermore, the steam accounted for by the diagrams when the jackets were in use

was much larger in the low-pressure cylinder than in the high-pressure cylinder; while, on the contrary, when the jackets were shut off, the steam accounted for was much less in the low-pressure cylinder than in the high-pressure cylinder."

There is no doubt that these results will do much to turn the attention of engine designers to other methods, and it is possible that the very moderate steam economy shown by the use of the jacket will help to advance the revival of superheating, to which many are already beginning to turn. It is very probable that a satisfactory superheater could be constructed at a cost but little, if any, greater than that of the jackets and reheater, while the experiments and tests by many competent observers have demonstrated that an economy of 15 to 20 per cent. is shown by a superheating quite within the limits of daily practice.

Power From Blast-Furnace Gases.

THE possibility of generating power from the discharge gases from blast furnaces, to which reference has been made here already, is continuing to attract attention, and an editorial in the *Iron Age*, in discussing the paper presented by Herr Lürmann before the *Verein Deutscher Eisenhüttenleute*, takes the position that, "as matters now stand, furnace managers in the United States will not rush into this field, however temptingly held out to those who may admire the gas engine, but know little concerning the conditions governing blast-furnace work."

The main points brought out by Herr Lürmann were, first, that blast-furnace gases contain dust, metal, and injurious vapors, unfitting them for use in the cylinders of gas engines, and, second, that, if all blast-furnace operators should take up with the idea, the builders of gas engines would be totally swamped with orders, and that it would take years to supply the demand!

It would have given a fairer idea of the position of the German ironmasters on this subject, if some of the points made in the discussion of Herr Lürmann's paper had been given, for it appears that his

views were by no means generally accepted by his hearers.

So far as the sad outlook of an enormous demand for gas engines is concerned, this curious objection was promptly met by Herr Schum, of the Otto works at Deutz, who called attention to the fact that every steam-engine works in the empire could undertake the construction of gas engines at short notice, and that there was little reason to fear that the machine shops of Germany would prove unequal to any demand upon their productive capacity.

The views of so experienced engineers as Körting, Helmholtz, and Schürmann, were at variance with the position of the author of the paper, and showed that the quality of the gas could readily be improved by proper engine construction, and that the dust and impurities could readily be separated.

It seems only natural that so radical a proposition as that of using this hitherto wasted source of power should pass through the customary routine of opposition, toleration, and adoption, but, when the advantages are so apparent and the opposition so feeble, it is evident that the stage of adoption cannot be long delayed.

In another place in this issue will be found a very complete discussion of the whole subject from the pen of Mr. W. H. Booth, than whom no one is better fitted to appreciate its importance and grasp its difficulties; when his full exposition is placed in comparison with the objections of Herr Lürmann, it will not be difficult to come to an intelligent conclusion concerning the value of the idea.

The matter of the gas engine itself is already being solved on both sides of the ocean, and the large gas engine will promptly be in evidence so soon as there is a ready market for it. This subject, too, has already been fully discussed in recent issues of this magazine. When, the blast-furnace men get ready to use their present waste products in motors of large or small size, the ranks of the builders of gas engines will be rapidly reinforced from the ample machine-shop capacity of the entire United States.

Refractory Surfaces in Furnaces.

IT is a common mistake in steam boiler design to assume that the best results will be obtained by bringing the heating surfaces of the boiler close to the fuel bed, with the idea that in this way the greatest amount of heat will be abstracted from the burning fuel.

An article by Mr. W. H. Booth, in the *American Machinist*, shows very clearly the fallacy of this idea, and states the conditions of favorable combustion in boiler furnaces.

"There is one grand principle: No substance will ignite unless first raised to a certain temperature, and it will not burn freely unless allowed to get hotter than the minimum temperature of ignition. Applied to coal and coal gas, we may set down the minimum temperature of ignition at, say, 800° F., and the minimum temperature for continued combustion at 1,000° F. A full furnace temperature may well be 2,500° F., and this is ample to throw off large volumes of gas from freshly-charged fuel and to set it burning freely. But, if we allow these freshly-ignited gases to flow among a nest of cold water tubes, the gas will be so cooled that its further combustion will be either stopped or rendered very imperfect. An example, well known in the laboratory, of cooling a flame to the point of extinguishment is the placing of a coil of platinum wire round a candle flame, which may thereby be cooled out altogether."

This principle is well borne out by the excellent results which have been attained by boiler settings in which the furnace and combustion chamber are altogether removed from the boiler itself, being placed in front, the burning fuel having an arch of fire-brick over it, absorbing and radiating heat and permitting a maximum furnace temperature to be attained. The intensely hot gases can then come into contact with the relatively cooler boiler surfaces without detriment, as the combustion has been fully effected and cannot be checked by any cooling action.

A similar effect can be obtained in the case of internally-fired boilers by partially lining the firebox with firebrick.

"Experience alone can decide how much brickwork should be used. It may be placed so as to afford a cellular structure, the plates being exposed at the openings only. It may be placed as a series of narrow rings, each of which will stop the flow along the plates of any stream of quenched gases, and compel them to pass over regenerating surface. The use of unlined furnaces with blocks of firebrick in the flues beyond the boiler is, to my mind, wrong. It is an endeavor to remedy, by the giving out of heat taken up from a bright and clear fire, a fault which should not have been made. It is, in fact, an attempt to return to the gases heat which ought not to have been abstracted from them in the furnace. Therefore the system is faulty. The refractory material should be in the furnace, and the gases should be left to remain hot as long as necessary for perfect combustion, instead of being too promptly robbed of heat, only to be reheated beyond the bridge, where, if kept originally hot, they would complete their combustion, and only then be fit to be cooled by water contact."

Liquefied Air.

WE have already noted in these columns some of the properties of liquefied air as produced in Germany by Professor Linde, and since then the subject has been brought into prominence in the United States by Mr. Charles E. Tripler, of New York.

Mr. Tripler's experiments and apparatus are very fully described in an article in *Engineering News*, in which it is shown that the apparatus is practically identical with that used by Linde, the question of priority being a matter of dispute, which time will doubtless decide. Leaving this feature for the present, the principal questions in the matter for solution are, first, the cost of production of the liquefied air, and, second, the possible uses for it.

The first thing required for the production of liquid air is a reduction to the critical temperature, above which it is impossible to liquefy it by pressure. This critical temperature, according to Professor Dewar, is about -2200 F., and, when this is attained, the air can be liquefied by a press-

ure of about 1,500 pounds per square inch, although in practice the gauge shows from 2,200 to 2,300 pounds. The low temperature is obtained by compressing a portion of the air and permitting this to expand in an annular space about an inner chamber also containing compressed air, and, as the pressure of more than 2,000 pounds is above that necessary for liquefaction, the liquid forms as soon as the critical temperature is reached.

Many details, including the purifying of the incoming air, and the removal of the heat of compression, etc., require attention, but the fundamental principles are as stated.

According to computations, based both on the experience of Mr. Tripler, and the figures of Professor Ewing from Professor Linde's work, the production is between 0.7 and 0.8 pounds per h. p. hour, so that the actual cost is about 15 cents per gallon, not including interest, rent, insurance, or depreciation of plant.

Turning now to possible applications of liquid air, there seem at present to be but two available, apart from lecture-room experiments and laboratory work. The first and most obvious is that of refrigeration. "For ordinary refrigeration it is quite unlikely that the ammonia machines at present in use will be supplanted, as tests have shown them to be more efficient than any form of compressed-air machines; but for special refrigerating purposes, where very low temperatures are desired, or where it is desired to store a large amount of re-

frigerating effect in a small space, liquid air would seem to be admirably adapted."

"The most important by far, however, of the probable future uses of liquid air appears to be the storage of power. At the present time there are only two methods known to engineers by which considerable amounts of power can be stored with apparatus of moderate weight and bulk. These are the electric storage battery, and compressed-air tanks, both of which have only been developed so as to be commercially practicable within the last few years. It now seems probable that in liquefied air we are to have a new method of storing power, considerably more expensive, it is true, than the older systems, and returning a smaller proportion of the power originally applied; but having the very great advantage of storing several times as many foot-pounds of energy in a cubic foot or a pound as the older systems."

Very much will depend, of course, on the efficiency which may finally be attained in its production, and the consequent reductions in the cost of the process. The success already attained, however, makes it reasonable to expect that the near future will see liquid air used to store power for such purposes as torpedo propulsion, where cost is a secondary consideration, and perhaps for the propelling of bicycles and motor carriages, and similar purposes where the storage of the maximum power with the least weight and bulk is more important than expense."

THE BRITISH PRESS

Underground Water-Supplies.

THE use of wells as a source of water-supply is never to be recommended, but in many cases there is no other available source, and, with certain precautions, water obtained from underground channels may be used with far more safety than is generally supposed possible.

In a paper read before the Society of Engineers by Dr. John C. Thresh the protection of underground water-supplies is discussed in a very thorough manner, and a number of valuable points are brought out.

While the value of chemical and bacteriological analysis is admitted for many purposes, it is of little avail for purposes of practical protection, since waters chemically above reproach may be ready carriers of disease, while the bacteriological examination can reveal the deadly bacilli only after the pollution has occurred and much of the harm has been done.

While the water obtainable from underground supplies has the same origin as that of rivers and streams,—*i.e.*, the rainfall,—the manner of protection against pollution is different in the former case from that which is obvious in the latter. The impossibility of insuring against contamination all the water which may ultimately enter a well renders it necessary to know whether natural filtration will take place in a degree sufficient to remove the bacilli of disease.

The investigations of Pettenkofer, the researches of Hauser, and the experiments of Martin and Robertson, tend to prove that typhoid and cholera bacilli can flourish only near the surface and in a polluted soil, and Fraenkel shows that the subsoil is free from germs even when the soil above has been contaminated for a long period. Dr. Thresh's own investigations in sand at various depths show that very few organisms are found at a depth of four feet, none occurring at a depth exceeding five feet. In fissured strata, of course,

these conditions do not hold good, and in such cases the inflow from possible sources of contamination must be carefully prevented. The principal difficulty with shallow wells, such as supply water for nearly one-third of the population of the British islands, lies in the absence of precautions against pollution, but there is no good reason why this should be so. Although the use of water from shallow wells sunk in populous neighbourhoods is not to be commended, there is very little doubt that in many such places a perfectly safe water-supply may be derived from the sub-soil. The essential features are the prevention of the entrance of water from any point less than six feet below the surface, and the absence of any cesspool within the area of the cone of drainage, say, from forty to sixty feet distant.

For deep wells from which a large supply is to be drawn we cannot do better than to repeat Dr. Thresh's directions as to the protection which should be given to the well.

"There should be an area of ground around each well under the absolute control of the purveyors of the water. The well should be constructed so as to admit water only at the lowest point possible. If the pumping machinery is in or over the well, care should be taken to prevent dirt of any kind, especially from the workmen's boots, from reaching the water. The immediate vicinity of the well should either be uncultivated or laid down to grass, but not fed. An outer ring should be similarly laid down, but cattle may be permitted to feed thereon. These two rings may be called the inner and outer protective areas, and the inner ring should be so protected that no one can enter 'except on business.' The area of this inner ring should be, at least, as large as the area of the cone of depression produced by the pumping. For example, suppose that 45,000 gallons are being pumped per day

from a sandy subsoil, and the depression of the water-level in the well caused by the pumping is 9 feet. Each cubic foot of the saturated sand would yield about $1\frac{1}{2}$ gallons of water. To yield the 45,000 gallons, therefore, 30,000 cubic feet of the subsoil would be drained. The cone of depression having a depth of 9 feet, the area of its base would be 1,100 square feet, representing a circle with a radius of 17 feet, the well being at the centre. The cone, however, has not straight sides, and, to be perfectly safe, therefore, a radius of 30 feet had better be allowed. The outer protective area should have a radius of 70 to 100 yards, if possible."

If the well is thus protected, and chemical and bacteriological tests are made at frequent intervals as a precautionary measure, the probability of disease from such a source of water-supply is very remote.

Possible Economies in Steam Auxiliaries.

ALTHOUGH the wastefulness of much of the auxiliary machinery both in vessels and in shore power plants has been known for a long time, it is only recently that definite efforts have been made to reduce the losses and attain a measure of economy in this direction at least approaching that of the main engines.

In the last issue of this magazine the subject of a central electric power plant on shipboard was ably discussed by Mr. Shepard, and a review of the tests of the machinery of the Minneapolis was given. The matter is also being agitated in the British navy, especially in connection with the cruise of the *Powerful* and the tests of the *Terrible* and *Diadem*.

There is a general unanimity as to the fact of wastefulness, but a decided difference of opinion as to the best methods of improvement.

Mr. Shepard has shown that there are many objections, both financial and operative, against the plan of a central electric plant, and it is possible that compressed air or hydraulic power would be free from many of the objections which attach to electricity for this purpose.

It may be, however, that there is sufficient room for improvement with the

present system of steam auxiliaries to render any radical change unnecessary. There certainly should be, when we remember that on the *Minneapolis* steam-consumptions of 100 to 300 pounds per h. p. per hour were the rule, and 55 pounds was the minimum.

In the discussion upon the trials of the *Diadem* at the meeting of the Institution of Naval Architects this question of losses at other points than the main engines was the principal topic, and some interesting points were brought out. One of the greatest difficulties in connection with many of the engines is the necessity of making the cylinders large enough for the maximum duty, when for the greater part of the time they are operated under very light loads. The use in the auxiliaries of pressures as high as those best adapted for the main engines is also a cause of loss, as the absence of any reasonable degree of expansion in the small cylinders, and the presence of large clearances cause a large proportion of energy to pass out with the exhaust.

In view of the fact that there is so little expansion of the steam in the cylinders of the auxiliaries, a suggestion made by Mr. Yarrow is in point. He proposed that the exhaust from the auxiliaries, instead of being condensed or wasted, should be delivered to the receiver of the main engines communicating with the low-pressure cylinder, where it would have an opportunity to do work while expanding. The principal difficulty of this plan, as Sir John Durston points out, is that it would interfere with the handling of the main engines.

Another method of economising, and one which has been suggested both in England and in the United States, is to use the exhaust steam from the auxiliaries for the purpose of heating the feed water; in this way, indeed, much of the heat could be retained.

The true principle, however, lies in the improvement of the auxiliaries themselves, as regards economy in performance; in this direction there is ample room for saving. Pumps should not be permitted to have a variable stroke, but should oper-

ate at a minimum clearance at all times. Engines which operate at little or no expansion should be fed with steam at a reduced pressure, and should not be allowed to use direct boiler pressure of 180 to 200 pounds.

In many cases where more than one machine is required different sizes could be installed, so that light work might be performed by a small engine running at full capacity, and the larger one used only when there was enough work to require it. Far more care should be taken to prevent pipe condensation; all pipes should be so well covered that the loss from this source would be reduced to a minimum, the discomfort from heat being also diminished.

In these and other ways the losses now occurring in the auxiliary machinery could undoubtedly be so reduced as to give a great measure of immediate relief without involving the necessity of a change so radical as the introduction of any form of central power plant.

Feed-Water Heating with Live Steam.

THE advantages of heating the feed-water for boilers are well known and generally admitted, but usually it is attempted to use for this purpose some source of heat which would otherwise go to waste. In nearly all of the feed-water heaters in practical use the heat is either employed in the waste gases on their way from the boiler to the chimney,—the so-called economisers,—or else is abstracted from the exhaust steam.

In the former case a high degree of heating may often be obtained, and the economiser is sometimes regarded as a sort of preliminary boiler, following out the principle laid down by Rankine that the coldest water should meet the coldest gases and proceed gradually to the hotter surfaces. When exhaust steam is used, however, it is not practicable to obtain a higher temperature than 208 to 210° F., unless a sufficient amount of back pressure is permitted in the engines to obtain exhaust steam of a temperature higher than that of the boiling-point of water.

Various plans have been made, how-

ever, to use live steam taken directly from the boiler, and therefore of a temperature corresponding to the boiler pressure, and with this plan the feed-water may be made much hotter than with any form of exhaust-steam heating device.

Theoretically there does not seem to be any reason for economy in this proceeding, for whatever heat is given to the water is abstracted from the boiler, which is like taking money from one pocket to put it in the other. Experience has shown, however, that there is a decided advantage in thus using live steam to heat the feed-water, and in a recent number of the *Engineer* the possible reasons for this apparent anomaly are discussed.

The usual method of computing the gain due to heating the feed-water is based upon the actual number of heat units supplied, and upon this basis the maximum possible gain within the temperature limits of ordinary practice is about 15 per cent. When, several years ago, Mr. John Kirkaldy stated that the use of live steam for heating feed water showed a gain decidedly greater than that which had been considered possible, there was a general feeling of incredulity; but, since many practical tests and years of undoubted experience have sustained the facts, a satisfactory explanation of this curious action is now thought to be in order.

Both Professor Unwin and Mr. Macfarlane Gray have expressed opinions upon the subject which seem worthy of consideration, and which also remind us that there are matters to be taken into account other than mere temperature differences, when the generation of steam is to be considered. In explanation of the increased economy due to live-steam heating, Mr. Macfarlane Gray says that water at the same temperature as the steam is more mobile than cold water, circulates more freely, and is more efficient in taking up heat from the metal surfaces. A similar view was expressed by the *Engineer* several years before, as the following quotation will show: "It is clear that the efficiency of a boiler working with hot feed will be greater than the efficiency of a

boiler working with cold feed. The Kirkaldy heater is supplied with steam from a boiler with feed-water at a very high temperature indeed, and the efficiency of each pound of fuel employed to heat that feed will be greater than it would be if the steam were supplied by a boiler working with cold feed. Each unit of heating surface will probably, in a given time, transmit about the same quantity of heat, whether the water in contact with it is 200° or 350° or even hotter; but it is obvious that, if the water be very hot, more steam will be produced in a given time per unit of surface than if it is cold. The result is equivalent to an augmentation of furnace heating surface."

It has been long a practice in the United States to use live-steam feed-water heaters, not so much for the purpose of effecting a direct economy in boiler performance as to purify the feed-water by precipitating the sulphates which may be contained in it. It has been reasoned that at least there could be little or no loss, since the heat is ultimately all returned to the boiler, while the freedom from scale in the boiler is considered an important advantage. It is a matter of experience that such heaters are not wasteful, and hence this experience is at least not opposed to the conclusions of the *Engineer* and of later investigators.

Evaporation in Water-Tube Boilers.

THE question of the behaviour of the water in modern small-tube boilers has been discussed from various standpoints, and attempts have been made with more or less success to determine from experiments with glass tube models just what actually occurs with various forms of construction.

Among the experimenters no one has been more indefatigable than Mr. Yarrow, and some of his experiments as to the necessity or otherwise of using downcomer pipes have generally been regarded as conclusive.

Mr. Yarrow's latest experiments are given to the profession in a paper read by him before the Institution of Naval Architects, and published in *Engineering*; and,

from the fact that the tests which form the basis of the paper were made upon a full-size working boiler, they are of greater value and interest than if a small model had been used.

The present tests were made with a view of showing the effect upon the evaporation of changing the point of introduction of the feed-water, and, although the specific details apply to the boiler with which Mr. Yarrow's name is associated, yet the principle is true for other forms, and, indeed, was enunciated long ago by Rankine, although often ignored by steam-boiler designers.

The experiments consisted in making careful evaporation tests, first, with the feed introduced in the ordinary way, mixing at once with the water already in the boiler, and then, by partitioning off three outer rows of tubes on each side by means of diaphragms in the bottom pockets, delivering the feed into these outer tubes at the bottom and requiring it to pass through them before it mingles with the main volume of water.

Temperatures at various points were carefully taken, using the Le Chatelier pyrometer, so that the conditions under which the water was evaporated were obtained, the analyses of the flue gases showing the excellent character of the combustion.

The results of the tests are very clearly shown in a graphical diagram, curves giving the evaporation per pound of coal at various rates of firing. The advantage of thus feeding the water into the outer tubes first is shown by the diagrams to amount to nearly 20 per cent., being nearly 12 pounds of water per pound of coal for the new method of feeding as against 10 pounds for the usual method, diminishing somewhat as the boiler was forced above its normal capacity.

The principle involved in feeding a boiler in this manner is much the same as that involved in the use of an economiser in the flue, exposing the cooler water first to the action of the cooler gases; and the results of these trials confirm the soundness of this principle and the wisdom of applying it.

Telegraphy Across Space.

WE have heard much during the past few months about the so-called "wireless telegraphy," both as to methods and results, with some admixture of the "horrid wrangling about priority" which inevitably accompanies the development of any new subject.

Among the various articles upon this subject it is refreshing to meet with so clear and satisfactory a paper as that presented before the Society of Arts by Professor Sylvanus P. Thompson, and published in the *Journal* of the society.

Professor Thompson begins by objecting to the term "wireless," and shows that there can be no such thing as wireless telegraphy, since base-line wires of considerable length must be used, even when there is no direct-connecting wire between the two stations. The methods of telegraphing across space are divided into three classes, as follows:

- (1) Conduction methods;
- (2) Induction methods;
- (3) Wave methods.

Those of the first class depend upon the use of water or earth as a means of conducting a fraction of the electric current from the base-line at the sending end to the base-line at the receiving end.

Those of the second class, or induction methods, are better known in connection with the successful attempts of Phelps, Gilliland, and Edison to telegraph to or from moving trains, and the principles involved are the same that sometimes permit telegraph or telephone messages to be overheard in instruments upon totally disconnected lines, and that explain the interruption of telephone communication with a roaring or buzzing noise caused by induction from neighbouring wires.

At the present time, however, practically all the investigations are being made with methods of the third class, or wave methods, and it was of them that Professor Thompson principally spoke.

The predictions of Clerk-Maxwell and the experimental researches of Hertz first called attention to electromagnetic waves, and, after the death of Hertz, the work which he had begun was carried on by a

number of investigators, among whom Professor Lodge, M. Branly, and Sig. Marconi are best known. Hertz had first pointed out the existence of a true travelling wave. Hitherto there had been known inductive actions reaching out from wire to wire and falling back when the exciting cause died away. The true electric wave, however, when once started on its path, did not collapse into the wire when the spark ceased, but, on the contrary, went travelling on. Such a wave, Hertz showed, could be started by a simple apparatus called an "oscillator," consisting of two metal plates or conductors connected by a conductor interrupted at one intermediate point by a "spark gap," the oscillator, on the appearance of each spark, emitting a train of waves into the surrounding space.

To receive such waves some form of "detector" was necessary, and many forms have been proposed. The detector now found most effective is the so-called coherer, suggested by Branly and developed by Lodge, and consisting of a small glass tube partly filled with loose metallic filings, such as iron or silver, joined in the circuit.

The passage of an electric wave throws the coherer into the conductive state, making the connection with a local circuit much as it is made in the case of a telegraphic relay, and, after the passage of the wave, the coherer may be thrown into the non-conductive state by tapping or jarring,—an operation easily performed mechanically.

With these simple pieces of apparatus Lodge first sent messages a few hundred yards, followed by the experiments of Marconi, who, with the assistance of the British telegraph department, sent signals from Lavernock Point to Bream Down, a distance of about nine miles, and subsequently at Spezia, over the open sea, maintained communication between points about 11 miles apart.

In Germany Professor Slaby, using the Branly-Lodge coherer and base-lines 200 to 950 feet in length, communicated over an open stretch of country from Rangsdorf to Schoneburg,—a distance of 13½

miles,—and he is of opinion that over open sea a much greater distance appears to be attainable for a given base-line than over land.

In conclusion Professor Thompson says :

"It has been shown that there are three general methods of transmitting electric signals across space. All of them require base-lines or base-areas. The first—conduction—requires moist earth or water as a medium, and is, for distances under three miles, the most effective of the three. The second—induction—is not dependent upon earth or water, but will equally well cross air or dry rock. The third—electric wave-propagation—requires no medium beyond that of the ether of space, and is, indeed, interfered with by interposed things, such as masts or trees. Given proper base-lines or base-areas; given adequate methods of throwing electric energy into the transmitting system, and sufficiently sensitive instruments to pick up and translate the signals,—it is possible, in my opinion, so to develop each of the three methods that, by any one of them, it will be possible to establish electric communication between England and America across the intervening space."

The Simon-Carves Coke Oven.

NOTWITHSTANDING the fact that in the ordinary beehive coke oven there is an entire loss of several valuable bye-products, by far the greater number of coke ovens in use in all parts of the world are of this primitive type.

Numerous attempts have been made to produce successful retort ovens in which the bye-products can be saved, and prominent among these may be named the Semet-Solvay, Otto-Hoffmann, Festner-Hoffmann, Hüssener, Seibel, and Simon-Carves ovens. Among these the Simon-Carves oven has been found to yield excellent results in practice, and from an account of several installations of this type of oven, in a recent issue of the *Iron and Coal Trades Review*, we give some details as to performance and economy.

The beehive oven, as is well known, cokes the coal by "internal" combustion, the fuel being the gas distilled and a small

portion of the carbon, the admission of a sufficient quantity of air being also necessary. By the Simon-Carves system the coal is converted into coke by heat transmitted to the coal through the oven walls, such heat being obtained by burning the gases from the coal, as they circulate outside and along the side and sole of each oven, after the tar, benzol, and ammonia have been abstracted. All air is excluded from the inside of the oven, so that no carbon can be burned, and heat is applied externally, as to a closed retort.

The bye-products are secured by drawing the distilled gases from the retorts by exhausters, the tar and ammonia being collected partly in hydraulic mains and partly in condensers and scrubbers, and the benzols and light hydrocarbons in oil scrubbers, after which the gas is led back to the flues around the exterior of the retorts, there to be burned as fuel.

When the coke is ready to be discharged from an oven, the coal for the next charge is got ready over the charging holes, situated above the retort. The two end doors are then opened, and the mass of coke pushed out from the back of the oven on to the coke platform by means of a ram worked by a portable steam engine running on rails in front of the ovens. As soon as the coke has been discharged the end doors are closed, the charging holes are opened, the coal is charged, and the coking process begins afresh.

Besides the value of the bye-products recovered by the use of retort ovens, there is a further gain in the increased product of coke from a given quantity of coal. Out of 100 tons of Durham coal about 75 tons of coke are obtained by the Simon-Carves process, whereas by the old beehive process the yield does not exceed 60 tons, and all the benzol, ammonia, tar, etc., are lost.

A large number of these retort coke ovens have been installed at Durham, and others are soon to be erected. Notwithstanding the greater first cost of the plant, there seems every reason to believe that the increased output of coke and the realisation of the value of the bye-products will return a handsome profit on the outlay.

The Progress of Electric Traction.

As the statistics of tramway construction and operation for the past year begin to be made public, comparisons between various countries can be made, and an outline of probable progress for the future mapped out. A general review of this subject, with especial reference to electric traction, is given in the *Railway World*, and some of the conclusions drawn from the tabulated figures are very interesting.

Referring first to Europe, including both the United Kingdom and the continent, the development has been rather in point of equipment than in mileage.

"The relatively light increase of lines as compared with the increased capacity of the power stations and motor cars indicates that the development of electric tramways has principally occurred in the larger cities and systems. Germany stands at the head, with a length of 386 miles and 1,631 motor cars, as against a length of 538 miles and 1,469 motor cars in all other European countries. If, however, the superficial area and the population of the different countries are taken into consideration, Switzerland, which, in regard to the absolute length of lines and number of cars, is classed as fifth, with 17 lines, a total of 47.5 miles, and 129 motor cars, heads the list."

In the United Kingdom there are 127 miles of track and 221 motor cars, figures exceeded only by Germany and France, and seeming very small beside those of the United States, where there are no less than 16,250 miles of track now in use and about 45,000 motor cars, these being operated by 1,350 companies, and representing an investment of more than one hundred pounds sterling.

"The successful developments, both electrically and mechanically, in the United States have commenced to encourage other countries to follow American practice. As a compensation for delay, it may, however, be considered that the conservative tendency of the managers of European tramways have prevented their rushing into electric traction until such time as the untried methods have been proved successful, both practically and

commercially; but now that the experimental tests of the past ten years have given unquestionably successful results, and are considered to be the standard for the construction of tramways and light railways, Europe is energetically substituting electricity for horse and steam power, and legislative restrictions are being modified to encourage the employment of capital to furnish better means of transportation to the travelling public."

The rate of progress in England may be gathered from the fact that there are now under construction nineteen electric tramways, the permanent way of which comprises about 277 miles of track, and also five important electric railways, now open or under construction, having a total track-mileage of 38.

"Progress has not been so rapid as to draw great attention to the work which British firms have already done, but, as pioneers, they are entitled to much credit for results accomplished under very adverse conditions. They have courageously stood by the ship when underwriters looked askance at the strange craft; and, now that it has got into smoother water, they may justly claim some consideration for their efforts."

Water-Tube Boilers in the British Navy.

ALTHOUGH water-tube boilers have been successfully used in the smaller vessels of the navy for a number of years, especially in torpedo boats and destroyers, there has been a decided hesitancy about substituting boilers of this type for the well-tried cylindrical or Scotch boiler for large ships; and the installation of Belleville boilers in the *Powerful* and *Terrible* was not made without strong protest and some misgivings. It was this uncertainty as to the suitability of large water-tube boilers in general which led to the selection of the Belleville boiler rather than some English design, the experience with the Belleville boilers in numerous large vessels of the *Messageries Maritimes* since 1885 being considered sufficient to outweigh the objections.

The *Powerful* has now made a cruise

from Portsmouth to Hongkong, the result of which has been to evoke much criticism of the performance of her machinery, owing mainly to the large coal-consumption; and the opponents of water-tube boilers have naturally taken the opportunity of saying "I told you so."

In an editorial discussing this matter, *The Engineer* shows that much of the criticism is the result of insufficient information as to the conditions of the cruise, and especially demonstrates that the low economy was due to other causes than the performance of the boilers. Briefly, the fact is that the *Powerful*, on her voyage to China, consumed 8,300 tons of coal, and that, making due allowance for the steam used in the auxiliaries, the main engines must have required more than 2.75 pounds of coal per h. p. per hour.

As the *Engineer* points out, however, the rate at which the voyage was made required only about 3,000 h. p. to be developed by engines intended to exert 25,000 h. p. and, thus working at about one-eighth of her full power, it is strange that she did not require 4 pounds of coal instead of less than 3 pounds. There were some minor casualties in connection with the engines; some bearings got hot, one pump broke, and some similar mishaps occurred, but the only difficulty which occurred to the boilers was the discovery, in two of the down-take tubes, of sufficient corrosion to require their renewal.

The cruiser *Diadem*, which is also equipped with Belleville boilers, has just undergone her trials, and from the discussion at the meeting of the Institution of Naval Architects it appears that, when working at about 75 per cent. of the maximum power, the coal-consumption during a twenty-four-hour run was but 1.59 pounds per i. h. p. per hour; so that there could have been nothing radically defective about the boilers in that case, at least.

The weak point of the Belleville boiler

is its defective circulation, as is clearly shown by Mr. Gretchin's paper before the Institution of Engineers and Shipbuilders in Scotland upon the performance of the Belleville boilers in the Russian steamer *Kherson*. An illustration of these boilers will be found on page 433, Vol. XIV., No. 3, of this magazine, and from the construction it will readily be seen that the steam from the lower tubes must work its way up through the entire series above it before it can find its way into the main drum. In the case of the *Kherson*, this circulation at times became so feeble that the lower tubes were seriously overheated and sagged to an extent sufficient to produce leaks and give trouble. This, however, should not be taken as a characteristic of water-tube boilers in general, as in many other forms the circulation is all that can be desired.

There is no doubt that the water-tube boiler, in some form, will hereafter be the general type in the navy for all sizes. This is clearly the opinion of Mr. Goschen, who, in his remarks in the house of commons in connection with the criticisms of the trip of the *Powerful*, maintained that much of the trouble was due to inexperience on the part of the engineers and stokers.

Much better results will be obtained when the men have become trained to the proper use of the machinery. In the case of the *Kherson* it was found very difficult to get the stokers to keep the clear thin fires required by M. Belleville's rules. There is no more probability of going back to the cylindrical boilers for the navy than there is of the abandonment of breech-loading guns for muzzle loaders. Improvements will certainly be made, both in construction and in stoking, but the water-tube boiler will surely continue to be used to the exclusion of the enormous shell boilers of the present day, and increased pressures and reduced weights will follow as a natural consequence.

THE CONTINENTAL PRESS

The Properties of Nickel Steel.

BRIEF notices have appeared from time to time in the *Comptes Rendus* of the French Academy upon M. Guillaume's important researches into the physical properties of the various alloys of nickel and steel, but the complete details of these investigations have not been made public until recently.

A paper by M. Guillaume in the *Bulletin de la Société d'Encouragement* now describes the apparatus and methods used by him, and also gives the results of his researches more completely than they have been given heretofore.

While it is impossible, in the limited space here available, to examine the work of M. Guillaume at length, the peculiar properties which he has discovered possess sufficient importance to demand a brief indication, and may render the application of the alloys important for engineering purposes in different lines from those previously considered.

The principal object in view, in making these researches, was the discovery of the best alloy for metrological purposes, and the investigations covered the density, elasticity, magnetic properties, and behaviour under the action of heat. They were not intended to cover the entire magnetic properties of the various alloys, but only to use these as guides to the selection of suitable proportions for further investigation. These tests showed that alloys containing from 0 to 25 per cent. of nickel are irreversible,—that is, they possess two different sets of magnetic properties, according to the direction of the preceding temperature-changes, whether ascending or descending. For alloys containing 25 to 50 per cent. of nickel, on the contrary, the magnetic properties are reversible, depending at each temperature upon the temperature only, regardless of the preceding condition.

A similar condition of reversibility, or irreversibility, appeared in connection

with changes of volume, the irreversible alloys showing, within certain limits, absolutely different changes when subjected to ascending and descending temperatures. The reversible alloys expanded and contracted in the same manner, whether cooled or warmed, but seemed to follow laws altogether different from those governing other metals or alloys.

The peculiar behaviour of the irreversible alloys can be shown only by a diagram, but the expansion and contraction of the reversible alloys is tabulated in a very interesting manner. The formula for the coefficient of expansion is given in the shape of a constant plus a function of the temperature, but neither the constant or the coefficient remains the same for different alloys. As the proportion of nickel is increased, the coefficient of expansion diminishes until the minimum is reached for the alloy containing 35.6 per cent. of nickel, after which it again increases. At this minimum proportion the expansibility is only one-tenth that of platinum, and less than one-twentieth that of brass.

The great value of this alloy for standard measures of length will be seen at once, especially as it possesses other desirable qualities. The alloy is particularly homogeneous, takes a brilliant polish, remarkably free from flaws, and has a density of about 8 and a modulus of elasticity of about 20,000,000 pounds per square inch.

In order to attain the best results, the bar of this alloy is subjected to a prolonged elevation of temperature, lasting for several days, after which the molecules appear to have arranged themselves in the most stable position, so that the subsequent changes of length for differences of temperature are reduced to a minimum. The influence of this reheating also renders the small, but ordinarily somewhat variable, expansion coefficient practically constant. If it is desired to secure a variation of less than 0.001 millimeter in a

length of one meter, the bar should be maintained at a temperature of boiling water for 80 to 100 hours. A still greater degree of precision may be obtained by giving the bar a series of prolonged heatings for several hundred hours at successively diminishing temperatures; in this way bars for the measurement of geodetic base lines may be obtained with the temperature error practically eliminated.

A variation of 1 mikron per meter in the length of a pendulum corresponds to less than 0.05 second per day; in fact, a clock with a pendulum rod of this alloy has shown a rate of less than 0.02 second per day for a period of six months.

Although the researches of M. Guillaume are not yet completed, the facts which he has made public are of much value, and his full account of his work will be found both interesting and practical.

Compound Locomotives.

FOR several years past the Northern Railway of France has been endeavoring to improve its express service, and the result is the introduction of an improved form of compound express locomotive, of which a full account is given in *La Revue Technique*.

The engine is a four-cylinder compound, the low-pressure cylinders being placed inside the frames and coupling to the forward cranked axle. The high-pressure cylinders are outside, and connect to the rear driving axle, but have also parallel rods to connect both axles, although, from the experience of Mr. Webb on the London & Northwestern, it seems as if the parallel rods might be omitted. Doubtless this coupling of the axles has been done, in order to give better starting adhesion, this having always been a weak point with single drivers. A starting valve permits high-pressure steam to be used in all four cylinders, if necessary, although in this case the cylinder power will exceed the adhesion, unless the rails are well sanded.

The total weight of the engine is 50 metric tons, of which 31 tons are on the driving-wheels, and the cylinders are 13.4

inches and 20.9 inches in diameter respectively, and 25.2 inches in stroke, fitted with Walschaert valve gear.

Especial attention has been given to the boiler capacity, the intention being to have a sufficient power in reserve to enable the maximum effort to be exerted whenever necessary, without drawing down the pressure appreciably, and to enable power to be stored when the demand is slight, and held for future use. The total capacity of the boiler is 215 cubic feet, of which 142 is water capacity and 73 is steam space, there being 1,890 square feet of heating surface and 25 square feet of grate surface. The firebox is of the Belpaire type, and, as is customary in Europe, is made of copper, copper staybolts being used with holes in them to indicate by leakage the fact that a break has occurred.

These engines have only recently been installed, and no records of their speed are yet given out, although there is every reason to believe that they will enable the present express speed of the road—120 kilometers, or about 75 miles, per hour—to be surpassed.

Originally three engines were designed by M. Glehn, of the *Société Alsacienne de Constructions Mécaniques*, and the operation of these was sufficiently satisfactory to result in an order for twenty additional locomotives of similar construction.

Doubtless further reports will be made of the performance of these engines, and, in point of speed and of fuel-economy, they should give good account of themselves.

Radial Valve Gears.

ALTHOUGH the link motion successfully holds its own as a practical reversing valve gear for locomotive engines, with only a partial competition from the Walschaert single-eccentric cross-head combination in Belgium and Switzerland, other forms have been found more acceptable in many instances for marine use, especially the modifications of the so-called "radial" valve gear of Hackworth.

A general study of these radial gears, under the name of "single-eccentric valve gears," is given in a paper by Herr von

Berling, of the Imperial shipyard at Kiel, in the *Zeitschr. des Vereines deutscher Ingenieure*, with many comparative diagrams, enabling an excellent view of the various modifications to be obtained.

One of the principal advantages of the radial type of gear for marine engines is the fact that the natural construction brings the valve connection out at the side of the engine, whereas in the case of the link motion it is directly over the shaft.

This is especially convenient for multiple-expansion engines, since it enables the valve chests to be on the side of the cylinders instead of between them, making the parts much more accessible and permitting the engines to be more compactly designed. With the radial gears there are also certain advantages in steam distribution over that given by the link motion with two eccentrics, and some undesirable features in construction are avoided.

The general principle of all the radial valve gears consists in the use of a single eccentric, or even the main crank itself, through connection with the proper point on the connecting rod, in combination with some simple form of slide block or radius arm to provide for the proper angular advance and to permit of reversal. In the case of a vertical engine, for example, the eccentric, being set either in line with, or directly opposite, the crank, furnishes by the vertical component of its travel the necessary movement of the valve up to the port opening, while the opening and closing of the port are effected by some transformation of the horizontal component.

The original gear of Hackworth used a slide block, moving in an adjustable guide, the position of this guide determining the opening and closing of the ports and also the direction of the motion of the engine; and the gears bearing the names of Klug, Marshall, and Bremme are only modifications in detail of this fundamental form. The Joy valve gear, which has been applied both to locomotives and to marine engines, differs mainly in the substitution of a point on the connecting rod for the eccentric, there being therefore no eccentric used with this gear, al-

though its equivalent in motion is obtained. Klug and Bremme both have used radius arms in place of slide bars, and a variety of minor modifications have been made in all these main forms to meet special requirements.

Herr Berling gives a general analysis of the radial valve gear, using the Zeuner polar diagram, and shows by valve ellipses the variations in distribution which result from changes in proportions and arrangement; the applicability of the Reuleaux diagram is also shown.

In view of the increasing use of radial valve motions, especially for marine use, and also the limited amount of accurate information available outside of the designing rooms of great ship-building establishments, this contribution from the great shipyards at Kiel is to be welcomed, and will doubtless be made of use by many engineers and designers in marine work.

Fly-Wheel Explosions.

ALTHOUGH there have been numerous explosions, or rather burstings, of fly-wheels in various countries, especially since the general increase in rotative speeds in stationary-engine practice, the usual rules for the proportioning of this important part of an engine give little or no attention to the magnitude or direction of the stresses induced by centrifugal force. In some recent instances wheels have been made with wire-wound rims, or with built-up rims of wood, but most of the work in this direction has been empirical rather than precise or scientific.

For this reason the paper upon the direction and magnitude of the stresses in fly-wheel rims and arms which has appeared in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, by Herr J. Goebel, is a welcome contribution to the subject of steam-engine proportions. The paper was called forth by the fact that a fly-wheel in a rolling mill near Cologne burst under conditions which showed that the accepted theory, due to Grashof, could not be correct, even when the influence of possible shock was taken into account. A number of investigations of other and

similar disasters were then made, and upon the results of these researches the paper is based.

According to the general theory, the stress induced in the rim of a fly-wheel by centrifugal force is similar to that produced in the shell of a boiler by internal pressure, and tends to cause a circumferential strain in the metal of the rim. Such stresses can easily be computed, being dependent only upon the diameter of the wheel and the number of revolutions, and, for any given speed-and-stress limit, the maximum diameter permissible is readily found.

In actual practice, however, the rim is not a free ring, but is restrained by the arms from assuming an enlarged circular shape under increased stress. Instead, there is a bending action in the segments of the rim between the arms, together with a longitudinal pull upon the arms themselves, while, if there is any acceleration or retardation of speed, there will be also a bending action on the arms, and a shifting of the points of greatest stress in the rim segments.

These various forces are taken up by Herr Goebel successively, the treatment being mathematical in its nature, but entirely applicable to practical use. In every instance the stresses due to each action may be computed separately, and it can then be seen which is the greatest, and the proportions can be made to correspond.

Another point demanding especial attention is the manner of securing the various parts of the wheel together; it is shown how fastenings amply strong in themselves may be so applied as to oppose only a portion of their strength to the stresses in the wheel. In the case of the wheel which burst at Cologne it is shown that the improper arrangement of rim connections was probably the cause of the original fracture, after which the other portions were, of course, destroyed.

The whole paper is an excellent study in itself, and the formulas will be found useful in future investigations of a form of breakdown which has become altogether too frequent of late.

The Utilization of Glacier Ice.

UNTIL recently the principal commercial value of the Alpine glaciers has been considered to lie in the attraction which they have offered to tourists, and the consequent revenue which has accrued to the skillful exploiters of natural scenery.

During the past year, however, a more practical idea has been developed, and the glacier du Casset, near Briançon, is now regularly operated as an ice quarry, the blocks being cut and conveyed over an overhead cableway to a convenient place for shipment by rail to Paris, there to be consumed in the cafés and hotels of the metropolis.

A fully-illustrated account of this curious industry is given in *Le Génie Civil*, with photographic views of the glacier and details of the methods employed.

A moderate clearing of the face of the glacier revealed a vertical front of ice 25 to 30 feet in height and about 100 feet in clear width, and from this quarry the ice is removed in blocks in the following manner. Vertical grooves 6 feet deep and about 8 feet apart are cut in the wall of ice, extending from the base to the top, and a similar channel is cut from the top downward behind the ice, the rear cut extending only about one-third of the way down. A small excavation is then made under the foot of one of the rectangular pillars, and a light blast of powder is sufficient to bring down the mass, usually in three or four large pieces.

These large blocks are further broken into pieces from 200 to 300 pounds in weight, and passed down slides to the loading platform of the cableway. The larger pieces are caught in grappling tongs, and the smaller ones packed in boxes, these being suspended from the trolleys. The ice is thus sent down the mountain side a distance of nearly a mile and a half, the difference in elevation between the two ends of the cableway being about 1,300 feet.

As the loads are always on the descending side of the endless cable, no other source of motive power is necessary than the weight of the ice itself, and a controlling brake device is used to prevent an

undue acceleration from taking place. At the lower platform the ice is unloaded from the trolleys into carts, and hauled to the railway station at Briançon, about ten miles distant, where it is shipped to Paris.

The cost of installation of the cableway, including the construction of the wooden supports and all details ready for operation, is given as 25,000 francs, and the daily cost of operation of the entire plant, employing about 30 men, is 150 francs. As the output is about 100 tons of ice per day, the cost is but 1.50 francs per ton, at the lower platform of the cableway. The cost of hauling to Briançon is about 6 francs per ton, and, including the wastage by melting in the summer time, the cost of glacier ice at the Briançon station is about 9 francs per ton.

As this interesting plant has been in successful operation since July of last year, there seems to be no doubt of its mechanical success, while its value as a commercial investment will probably depend somewhat upon the season, and upon the scarcity of ice from other and former sources.

Steel Cross-Ties.

THE use of metallic ties for railways is generally limited to warm countries, in which wooden ties, because of their short life, are more expensive in the end than the higher-priced ties of steel.

In south Africa it is practically impossible to use wooden ties since the ravages of the white ants soon destroy the wood. Steel ties are much used in Turkey, and a recent issue of *Le Génie Civil* gives an interesting account of the method of constructing the railway in Anatolia, including the special appliances which the use of metallic ties makes possible.

The ties used are of a mild steel, pressed into a channel shape, with the ends bent somewhat downward, and the rails are attached by bolts and cleats in such a manner as to form complete sections which can be handled as units. This does not permit of the placing of the joint between one pair opposite the middle of the rail on the other side; so the joints are placed

opposite each other. The rail used is about 32 feet long, and weighs 60 pounds per yard, 11 cross-ties being used to a length, and placed about 30 inches apart.

The sections thus prepared, when they are to be sent out on a construction train, are piled in the yard and loaded upon flat top cars by a travelling gantry crane. The engine by which this construction train is hauled is a curious affair; it carries a pair of cantilever trusses extending back over the car behind, and forward over the road-bed in front, being inclined toward the front. On this cantilever is a trolley crab, which can be run back over the car behind, and, picking up a complete section of track, carry it entirely over the locomotive and deliver it in position in front of the train. The locomotive is built with especial reference to the operations of this cantilever device, the smoke-stack being on one side.

The track sections are not piled directly upon the cars, but are upon small trucks resting on rails running the whole length of the train, so that, when the car next behind the cantilever is emptied, the load upon the next one behind can be run forward bodily, and thus the whole train of material can be delivered, the train being moved forward upon the newly-laid tracks.

As an example of the work which has been done in this manner, it is stated that on a section of straight road 3,132 yards, or about $1\frac{3}{4}$ miles, was laid in 13 hours, while, of course, a slightly slower rate was obtained on curved portions of the way.

Another example of the use of metallic ties is found on some portions of the St. Gothard railway, where they were originally introduced on the more difficult sections, it being feared that the strength of wooden ties would be insufficient. Some of these have been in use for more than ten years, and a recent report gives information as to their durability and serviceableness.

So far as durability is concerned, the results have been very satisfactory, except in the tunnels, where the dampness causes rusting; but even under these conditions the life of the steel sleepers equals that of wood, while on other portions of the road

the tendency to rust is very slight, and there is every reason to believe that the ties will last as long as the rails themselves.

Although the cost of the steel ties is more than 20 per cent. greater than that of the oak ties used in Switzerland, in the long run the metallic ties are found to be decidedly cheaper, not only because of their greater durability, but also because of their greater value as old material when their usefulness as ties is past.

Experiments with Diverging Nozzles.

IN the construction of jet apparatus of any kind it is well known that the flow through a nozzle is greatly affected by the shape and character of the nozzle itself. Many experiments have been made, both with liquids and gases, to determine the actual behavior of the flowing material, and the latest contribution to this branch of mechanical physics is a study of the flow of air through diverging nozzles, made by Professor Fliegner and published in a series of articles in the *Schweizerische Bauzeitung*.

The diverging nozzle forms an important feature in the steam turbine of de Laval, and it was to investigate the action of such discharge-tubes that the experiments were undertaken. The work was done in the mechanical laboratory of the Zurich Polytechnic, where excellent facilities for such investigations are to be had.

The compressed air was drawn from a tank supplied by a compressing pump driven by a hydraulic motor, and the conditions of operation were kept well under control.

Two nozzles were used, both of the same length,—i. e., 10 centimeters,—and both 5.17 mm. bore at the smallest part, the difference being in the angle of the diverging discharge portion. At three points in the side of the nozzle small apertures were made for the purpose of measuring the pressures, one opening being in the short cylindrical commencement of the tube, another near the outer end, and the third at the middle point.

Great care was found necessary in order to obtain the true pressure existing at any

given point in the nozzle, as discordant results were found if the stream was tapped, so to speak, either in the axis or at the outer portion, the indications being too low in the former case, and too high in the latter. A small tube was therefore inserted in the gauge hole, and adjusted so as to give the most uniform results. For this purpose Professor Fliegner found the needle of a hypodermic syringe to be the best form of connection, consisting as it does of a steel tube of fine bore with the end bevelled off in a manner well adapted to divert the air from the main jet into the gauge.

Many experiments were made upon nozzles with different angles and air at various pressures, and the results were plotted in diagrams to furnish data for the construction of curves to enable the fundamental laws to be deduced. There are a number of these diagrams in Professor Fliegner's papers, and to them the specialist must be referred, but the general conclusions may be here stated.

When the angle of divergence is small, the pressure in all portions of the jet is greater than that of the atmosphere. When, however, the angle exceeds 1° , under certain conditions a suction may exist. This curious action is shown by bringing a horizontal gas flame over the edge of the vertically-discharging air nozzle, when it will be seen that the flame is drawn down into the edge of the nozzle, from which a strong discharge of air is issuing, although the flame is at several millimeters, distance.

The tabulated results of the experiments also show that, while for cylindrical tubes the velocity continually diminishes, it remains practically uniform for the diverging nozzle. The ratio which the pressure in the tube bears to the atmospheric pressure also appears to have an important influence upon the distribution of pressure in the nozzle, and, when this ratio is less than 0.5, the pressure diminishes regularly throughout the nozzle in proportion to the increasing volume, but, when the ratio is greater than 0.5, a compression appears, instead of a reduction in pressure.

It was some of these results which led

Professor Fliegner to question the conclusions of de Laval in connection with the nozzles of the steam turbine, and to suspect that pressures measured at the periphery of the jet had been taken to represent the mean pressure of the whole section. The carefully tabulated and plotted results of these important experiments bear directly upon the proportioning of jets for this and similar purposes, and the publication of these results should be the means of saving much difficult and tedious experimental research in the future.

The Society of Civil Engineers of France.

THE celebration of the fiftieth anniversary of the existence of the Society of Civil Engineers of France, of which an outline is given in the *Moniteur Industriel*, recalls some points of interest in connection with the career and work of the organization.

The actual date of the anniversary was March 4 of this year, at which time an official meeting was held, but a more general celebration has been arranged for June 10-13 inclusive, at which time a full account of the history of the organization will be given, in public and official form.

The society was founded almost immediately after the revolution of February, 1848, by a group of former pupils of the Ecole Centrale, who believed that the time had come for the civil engineers of France to found an organization to advance their interests as corresponding interests had been advanced in England since 1818 by the Institution of Civil Engineers. The names of the original founders are worthy of record: MM. Alcan, Ch. Callon, Faure, Laurens, and Thomas; while among the early additions to the list may be mentioned MM. Bricogne, Polonceau, Yvon-Villarceau, and many others.

Although the first meeting was held in March, it was not until July 13 that the constitution was definitely adopted; hence the selection of this latter date for the celebration. At the end of the first year the membership numbered 135, the present membership being more than 2,700.

The greatest advances of the society,

both in membership and in influence, have been in connection with the International Expositions, which have been so directly connected with the work of the engineer as to be necessarily bound up with it, and a comparison of the growth of the society with the dates of the expositions will reveal the relation very clearly.

Not the least important work of the society is found in its official publications, of which there are the Bulletins and the Annuals. The Bulletins, which originally appeared only quarterly, have been issued monthly since 1880, and contain the records of the meetings, text of papers read, and abstracts of proceedings of other foreign societies bearing upon the general science of engineering, while these are subsequently collected into the bound volumes, of which 65 have appeared, containing about 800 original papers upon questions of value and importance relating to the profession of civil engineering.

A number of prizes have been founded by the society, representing an annual value of more than 80,000 francs, among which may be mentioned the annual prize of the gold medal of the society for the best paper of the year; the Nozo prize, awarded every three years, for the best engineering work executed during that period; and the Giffard prize, awarded triennially for the best discussion of a given subject.

Besides awarding prizes to others, the society has itself been the recipient of numerous honors. Among these are cited: the brevet of the government for services rendered in the national defence in the war of 1870-71; the Diploma of Honor of the exposition of 1878, and the Grand Prize at the exposition of 1889; the Diploma of Honor of the Antwerp exposition of 1894; the Grand Prize of the Bordeaux exposition of 1895; also a special medal and diploma from the French government for its work at the World's Fair at Chicago in 1893; and the highest award at the Brussels exposition of 1897.

In thus noting the growth and success of one of the great national engineering societies, it may not be amiss to note that it is by means of just such organizations

that the barriers of national prejudice are broken down. There is no wider republic than the republic of science, and, while engineers of all countries are true to their own countries in all that relates to strictly national affairs, they are also the broadest of cosmopolitans in all other respects. The great expositions have again and again been occasions for reunions of engineers of many nations, and in every case the love of science and the appreciation of the work of fellow-engineers of all lands has been found strong in its influence for international brotherhood. It has been so in the past, and already it is becoming apparent in connection with the coming exposition, in which, as in those which have gone before, the work of the engineer is of commanding importance and influence.

Modern Arch Construction,

AN interesting example of bridge replacement, enabling old and new work to be well compared, is found in the case of the construction of the new stone arch bridge over the Ill at Feldkirch in the Vorarlberg, Austria, of which an excellent general and technical account is given in the *Oesterr. Monatschrift für den öffent. Baudienst*.

The river at Feldkirch passes between rocky banks, affording excellent opportunity for good foundations, and ever since the middle of the thirteenth century it has been spanned by a single arch stone bridge. In old times this bridge was most important, as it formed part of the high road over which a great part of the travel passed between Italy and southern Germany, and it has always been carefully preserved and cherished under the name of the Bridge of the Holy Cross (*Heiligkreuzbrücke*).

The form of the old bridge was a semi-circular stone arch, the builders of six hundred years ago hardly daring to cope with the thrusts produced by flatter curves. In order to obtain the rise necessary for the span of 60 feet, the roadway was graded up on each approach, forming steep ascents. The narrowness of the

road—only 11 feet between parapets—made the use of the bridge very limited.

Historical associations have caused the replacement of this old work to be deferred again and again, and repairs and restorations have kept it together and in fairly serviceable condition; but finally it has been taken down and replaced by a segmental stone arch of modern design, which does not detract from the picturesque surroundings, but does afford satisfactory communication between the two banks of the stream.

Since the depth of the gorge afforded sufficient room for the highest water in the river, it was decided to lower the bridge enough to avoid the steep ascents at the approaches, and the new arch has a rise of only 15.6 feet for a span of 62.3 feet, or practically one-fourth of the span. Since the springings of the new bridge are nearly five feet higher than those of the old arch, there is a lowering of the roadway of about 10 feet, and the approaches are rendered very easy.

The computations for the new arch were made by the graphical method, both for uniform and variable loading, and the strain diagrams are given in the account of the work, the whole forming an excellent practical example of the modern method of arch design. The distribution of the statical load is so well effected that the line of pressure is scarcely diverted from the middle of the arch ring when one-half the arch is subjected to its maximum loading, and the increasing thickness of the ring from the key to the abutments provides for the increasing pressure.

The work of erection also involved the removal of the old arch, which was accomplished by first placing a wooden centring beneath, thus enabling the old work to be removed piecemeal. It was interesting to observe the manner in which six hundred years of exposure had affected the masonry; it appeared that the action of frost and weather had been only superficial, and that the inner work was in fairly good condition.

The work, while not of great magnitude, affords an excellent study of modern and mediæval arch construction.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, in the original language, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of \$1.35. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for \$2, forty for \$5, and one hundred for \$12.

This Coupon will be received by us in payment for any 15 cent article catalogued in the Engineering Index. For articles of a higher price, one of these coupons will be required for each 15 cents; thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.

The Engineering Magazine, New York:

Please send Article No. _____ to the following address: _____

Facsimile Not Good

With a supply of these coupons on hand, no letter writing is required. Simply fill in the number and your address. A stamped envelope does the rest.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

- | | |
|--|---|
| American Architect. <i>w.</i> Boston, Mass. | Bulletin de la Société d'Encouragement. <i>m.</i> Paris. |
| American Electrician. <i>m.</i> New York. | Bulletin of Dept. of Labor. <i>b-m.</i> Washington, D. C. |
| Am. Engineer and Railroad Journal. <i>m.</i> New York. | Bulletin of the Univ. of Wisconsin, Madison, Wis. |
| American Gas Light Journal. <i>w.</i> New York. | California Architect. <i>m.</i> San Francisco, Cal. |
| American Geologist. <i>m.</i> Minneapolis, Minn. | Canadian Architect. <i>m.</i> Toronto, Ont. |
| American Journal of Science. <i>m.</i> New Haven, Conn. | Canadian Electrical News. <i>m.</i> Toronto, Ont. |
| American Journal of Sociology. <i>b-m.</i> Chicago, Ill. | Canadian Engineer. <i>m.</i> Montreal, P. Q. |
| American Machinist. <i>w.</i> New York. | Canadian Mining Review. <i>m.</i> Ottawa, Ont. |
| Am. Manufacturer and Iron World. <i>w.</i> Pittsburg, Pa. | Century Magazine. <i>m.</i> New York. |
| American Shipbuilder. <i>w.</i> New York. | Chautauquan. <i>m.</i> Meadville, Pa. |
| Am. Soc. of Irrigation Engineers. <i>qr.</i> Denver, Col. | Chem. Met. Soc. of S. Africa. <i>m.</i> Johannesburg, S.A.R. |
| Annals of Am. Acad. of Pol. and Soc. Sci. <i>b-m.</i> Phila., Pa. | Colliery Guardian. <i>w.</i> London. |
| Annales des Ponts et Chaussées. <i>m.</i> Paris. | Compressed Air. <i>m.</i> New York. |
| Architect. <i>w.</i> London. | Comptes Rendus de l'Acad. des Sciences. <i>w.</i> Paris. |
| Architectural Record. <i>q.</i> New York. | Consular Reports. <i>m.</i> Washington, D. C. |
| Architectural Review. <i>s-q.</i> Boston, Mass. | Contemporary Review. <i>m.</i> London |
| Architecture and Building. <i>w.</i> New York. | Deutsche Bauzeitung. <i>b-w.</i> Berlin. |
| Architektonische Rundschau. <i>m.</i> Stuttgart. | Dingler's Polytechnisches Journal. <i>w.</i> Stuttgart. |
| Atlantic Monthly. <i>m.</i> New York. | Domestic Engineering. <i>m.</i> Chicago, Ill. |
| Australian Mining Standard. <i>w.</i> Sydney. | Eclairage Electrique. <i>w.</i> Paris. |
| Automotor and Horseless Vehicle Journal. <i>m.</i> London | Electrical Engineer. <i>w.</i> London. |
| Bankers' Magazine. <i>m.</i> New York. | Electrical Engineer. <i>w.</i> New York |
| Bankers' Magazine. <i>m.</i> London. | Electrical Engineering. <i>m.</i> Chicago, Ill. |
| Bankers' Magazine of Australia. <i>m.</i> Melbourne. | Electrical Review. <i>w.</i> London. |
| Berg- und Hüttenmännische Zeitung. <i>w.</i> Berlin. | Electrical Review. <i>w.</i> New York. |
| Board of Trade Journal. <i>m.</i> London. | Electrical World. <i>w.</i> New York. |
| Boston Journal of Commerce. <i>w.</i> Boston, Mass. | Electrician. <i>w.</i> London. |
| Bradstreet's. <i>w.</i> New York. | Electricien. <i>w.</i> Paris. |
| Brick Builder. <i>m.</i> Boston, Mass. | Electricity. <i>w.</i> London. |
| British Architect. <i>w.</i> London. | Electricity. <i>w.</i> New York. |
| Builder. <i>w.</i> London. | Elektrochemische Rundschau. <i>b-m.</i> Frankfurt. |
| Bulletin Am. Iron and Steel Asso. <i>w.</i> Phila., Pa. | Elektrochemische Zeitschrift. <i>m.</i> Berlin. |
| | Elektrotechnisches Echo. <i>w.</i> Magdeburg. |
| | Elektrotechniker. <i>b-m.</i> Vienna. |

- Elektrotechnischer Anzeiger. *s-w*. Berlin.
 Elektrotechnische Zeitschrift. *w*. Berlin.
 Engineer. *w*. London.
 Engineer. *s-m*. New York.
 Engineers' Gazette. *m*. London.
 Engineering. *w*. London.
 Engineering Assn. of the South. Nashville, Tenn.
 Engineering and Mining Journal. *w*. New York.
 Engineering Journal. *s-an*. Stanford Univ., Cal.
 Engineering Magazine. *m*. New York & London.
 Engineering News. *w*. New York.
 Engineering Record. *w*. New York.
 Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
 Eng. Soc. of Western Penn'a. *m*. Pittsburg, Pa.
 Fire and Water. *w*. New York.
 Forester. *m*. Washington, D. C.
 Forum. *m*. New York.
 Foundry. *m*. Detroit, Mich.
 Gas Engineers' Mag. *m*. Birmingham, England.
 Gas World. *w*. London.
 Génie Civil. *w*. Paris.
 Gesundheits-Ingenieur. *s-m*. München.
 Glasers Ann. f. Gewerbe & Bauwesen. *s-m*. Berlin.
 Gunton's Magazine. *m*. New York.
 Harper's Weekly. *w*. New York.
 Heating and Ventilation. *m*. New York.
 Ill. Carpenter and Builder. *w*. London.
 India Rubber World. *m*. New York.
 Indian and Eastern Engineer. *w*. Calcutta.
 Indian Engineering. *w*. Calcutta.
 Industries and Iron. *w*. London.
 Inland Architect. *m*. Chicago, Ill.
 Iron Age. *w*. New York.
 Iron and Coal Trades' Review. *w*. London.
 Iron & Steel Trades' Journal. *w*. London.
 Iron Trade Review. *w*. Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr*. Wash., D. C.
 Journal Assn. Eng. Societies. *m*. Phila., Pa.
 Journal of Electricity. *m*. San Francisco, Cal.
 Journal Franklin Institute. *m*. Phila., Pa.
 Journal of Gas Lighting. *w*. London.
 Jour. N. E. Waterw. Assoc. *q*. New London, Conn.
 Journal Political Economy. *q*. Chicago, Ill.
 Journal Royal Inst. of Brit. Arch. *s-q*. London.
 Journal of the Society of Arts. *w*. London.
 Journal of U. S. Artillery. *b-m*. Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m*. Chicago, Ill.
 Kansas University Quarterly. *qr*. Lawrence, Kan.
 Locomotive. *m*. Hartford, Conn.
 Locomotive Engineering. *m*. New York.
 Locomotive Firemen's Mag. *m*. Peoria, Ill.
 Machinery. *m*. London.
 Machinery. *m*. New York.
 Manufacturer's Record. *w*. Baltimore, Md.
 Marine Engineer. *m*. London.
 Marine Engineering. *m*. New York.
 Master Steam Fitter. *m*. Chicago, Ill.
 Mechanical World. *w*. London.
 McClure's Magazine. *m*. New York.
 Metal Worker. *w*. New York.
 Mines and Minerals. *m*. Scranton, Pa.
 Mining and Sel. Press. *w*. San Francisco, Cal.
 Mining Industry and Review. *w*. Denver, Col.
 Mining Journal. *w*. London.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m*. Vienna.
 Monatschrift des Württ. Vereines für Baukunde.
 10 parts yearly. Stuttgart.
 Moniteur des Architectes. *m*. Paris.
 Moniteur Industriel. *w*. Paris.
 Municipal Affairs. *qr*. New York.
 Municipal Engineering. *m*. Indianapolis, Ind.
 National Builder. *m*. Chicago, Ill.
 Nature. *w*. London.
 Nature. *w*. Paris.
 New Zealand Mines Record. *m*. Wellington, N. Z.
 Nineteenth Century. *m*. London.
 North American Review. *m*. New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m*. Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w*. Vienna.
 Physical Review. *b-m*. New York.
 Plumber and Decorator. *m*. London.
 Popular Science Monthly. *m*. New York.
 Power. *m*. New York.
 Practical Engineer. *w*. London.
 Pro. Am. Soc. Civil Engineers. *m*. New York.
 Proceedings Engineer's Club. *q*. Phila., Pa.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr*. La Fayette, Ind.
 Progressive Age. *s-m*. New York.
 Railroad Car Journal. *m*. New York.
 Railroad Gazette. *w*. New York.
 Railway Age. *w*. Chicago, Ill.
 Railway Magazine. *m*. New York.
 Railway Master Mechanic. *m*. Chicago, Ill.
 Railway & Engineering Review. *w*. Chicago, Ill.
 Railway World. *m*. London.
 Review of Reviews. *m*. New York.
 Revue de Mécanique. *m*. Paris.
 Revue Technique. *b-m*. Paris.
 Revue Universelle des Mines. *m*. Liège.
 Sanitarian. *m*. Brooklyn, N. Y.
 Sanitary Plumber. *s-m*. New York.
 Sanitary Record. *m*. London.
 School of Mines Quarterly. New York.
 Schweizerisches Bauzeitung. *w*. Zurich.
 Science. *w*. Lancaster, Pa.
 Scientific American. *w*. New York.
 Scientific Am. Supplement. *w*. New York.
 Scientific Machinist. *s-m*. Cleveland, Ohio.
 Scribner's Magazine. *m*. New York.
 Seaboard. *w*. New York.
 Sibley Journal of Eng. *m*. Ithaca, N. Y.
 Southern Architect. *m*. Atlanta, Ga.
 Stahl und Eisen. *s-m*. Dusseldorf.
 State's Duty. *m*. St. Louis, Mo.
 Steamship. *m*. Leith, Scotland.
 Stevens' Indicator. *qr*. Hoboken, N. J.
 Stone. *m*. Chicago, Ill.
 Street Railway Journal. *m*. New York.
 Street Railway Review. *m*. Chicago, Ill.
 Technology Quarterly. Boston, Mass.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
 Trans. Am. Ins. Electrical Eng. *m*. New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. Civil Engineers. *m*. New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w*. London.
 Western Electrician. *w*. Chicago, Ill.
 Western Railway Club. Pro. Chicago, Ill.
 Wiener Bauindustrie Zeitung. *w*. Vienna.
 Wisconsin Engineer. *qr*. Madison, Wis.
 Yale Scientific Monthly. *m*. New Haven, Conn.
 Zeitschrift für Lokomotivführer. *m*. Hannover.
 Zeitschrift f. Maschinenbau & Schlosserei. *m*. Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w*. Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w*. Berlin.
 Zeitschrift für Elektrochemie. *s-m*. Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m*. Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Alterations.

Alteration Work in Occupied Buildings. Illustrates the reconstruction of a front wall of sixth story of a Chicago building. 1000 w. Eng Rec—April 2, 1898. No. 19415.

Amphitheatre.

The Rapid Construction of Amphitheatres. (Construction Rapide d'Amphitheatres.) A discussion of the rapid construction of large stands of the amphitheatre form for enabling a great number of spectators to witness reviews and similar public spectacles. Data concerning the examples at Mirecourt and at Chalons are given. 1500 w. La Revue Technique—April 10, 1898. No. 19820 D.

Baths.

Public Baths at Pirna on the Elbe. (Volksbad in Pirna a. d. Elbe.) Description, plan and elevation of convenient new bath building of moderate cost. 1000 w. Deutsche Bauzeitung—March 23, 1898. No. 19857 B.

The Municipal Public Baths in Vienna. (Die Städtischen Volksbäder in Wien.) H. Bernaneck. With plans of the buildings, and data and tables showing the operation and extent to which the baths are used. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—March 25, April 1, 1898. No. 19843 each B.

See also Plumbing.

Cloister.

The Cloister of St. Jerome at Belem, Portugal. (Das Kloster Dos Jeronymos in Belem, Portugal.) A description of the beautiful Romanesque cloisters belonging to the cathedral of Belem, near Lisbon, with illustrations. 2500 w. Wiener Bauindustrie Zeitung—March 24, 1898. No. 19878 B.

Domes.

The Metal Dome of the City-Hall Tower, Philadelphia, Pa. Francis Schumann. An abstract of the official report of the writer upon the construction of the dome, giving interesting details. Ill. 12000 w. Pro of Engs Club of Phila—March, 1898. No. 19445 D.

Erecting.

A Traveling Building Erection Tower. Illustrates a tower derrick with special features, used on many high buildings in New York. 800 w. Eng Rec—April 23, 1898. No. 19729.

Fireproofing.

Experts' Report on the Pittsburg Fire. Reviews a report of Corydon T. Purdy on the conclusion of the Board of Experts appointed by fire underwriters to study the Pittsburg fire of May 3, 1897. 3500 w. Eng Rec—April 23, 1898. No. 19730.

Holland Tile Fireproofing in the Park Row Syndicate Building. Reviews the contest between manufacturers and the Board of Examiners of New York in regard to the flooring of the 30-story Park Row Syndicate Building. Illustrations of the defective work in hollow-tile

flooring. 1000 w. Eng News—April 14, 1898. No. 19594.

How to Build Fire-Proof. Francis C. Moore. A summary of important points discussed in a series of articles on this subject. 6200 w. Br Build—April, 1898. No. 19759 C.

Foundations.

Steel Foundations of Buildings and Electrolysis. Statements of General SooySmith and Mr. Geraldine, as published in the Chicago Tribune, calling attention to this danger, and claiming unmistakable evidence that the action of electrolysis has begun. 1000 w. Elec, N. Y.—April 20, 1898. No. 19687.

Grain Elevator.

The Steel Tank Grain Elevator "Great Northern" at Buffalo, N. Y. Illustrated description of the structural features, storage bins, operating machinery, &c. 3800 w. Eng News—April 7, 1898. No. 19457.

Hospital.

The Alland Hospital near Baden, Austria. (Die Heilanstalt Alland bei Baden.) Elevation and plans of this fine new hospital especially intended for patients affected with pulmonary diseases. The sanitary and disinfecting arrangements are fully described. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 18, 1898. No. 19841 B.

Hotels.

The Grand Hotel Royal at Budapest. (Grand Hotel Royal am Elizabethring in Budapest.) An illustrated description of the largest and handsomest hotel in Budapest, with floor plans, elevation and section. 1000 w. 2 plates, Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19847 D.

The Hotel Waldorf-Astoria, New York. W. G. Mitchell. A criticism of the design, with plans and illustration of one bedroom. 1700 w. Am Arch—April 2, 1898. No. 19402.

Library.

The New University Library at Basle. (Die Neue Universitäts Bibliothek in Basel.) Elevation, plans and details of book stack of this new university library. 1200 w. Deutsche Bauzeitung—March 26, 1898. No. 19858 B.

Mortuary.

The New Mortuary Building at Munich. (Le Nouveau Monument Mortuaire à Munich.) A. Dutreux. Photographic views and plans of the fine mortuary building recently erected at the eastern cemetery at Munich, Bavaria. 1000 w. 1 plate. Le Génie Civil—April 9, 1898. No. 19811 D.

Palace.

The Palace of Herrenchiemsee, and its Ornaments and Decorations. (Schloss Herrenchiemsee, seine Decorative Ornamentik und Figurale Plastik.) A descriptive account of this show palace of Bavaria, with several views of the interior decorations. 2500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19846 D.

Parliament Buildings.

The Parliament Buildings in Budapest, Compared with other Parliament Buildings. (Das Parlamentsgebäude in Budapest in Parallele mit anderen Parlamentsbauten.) August Prokop. A valuable comparative discussion of many of the legislative buildings of Europe with ground plans and photographic views. Two articles. 5000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—April 1, 8, 1898. No. 19844 each B.

Permanence.

Ephemeral Construction. Editorial on the evidence of real permanence in construction being sought in architectural work, and of great activity in this field. 1200 w. Br Build—April, 1898. No. 19758 C.

Post Office.

The Enlargement of the Imperial Post Office, Berlin. (Der Erweiterungsbau des Reichspostamtes.) With effective illustrations of this important public building. Two articles. 2500 w. 1 plate. Deutsche Bauzeitung—April 2, 9, 1898. No. 19859 each B.

Renaissance.

The Methods of the Masters of the Italian Renaissance. (Die Arbeitsweise bei den Meistern der Italienischen Renaissancezeit.) An address delivered before the Society of Architects at Berlin, March 13, 1898, by City Architect, Ludwig Hoffmann. Two articles, 3000 w. Schweizerische Bauzeitung—April 2, 9, 1898. No. 19836 each B.

Steel Construction.

American and English Practice in Architectural Steel Construction. Charles V. Childs. A comparison, with illustrations, of the different methods of construction existing in the two countries. 2500 w. Engineering Magazine—May, 1898. No. 19937 B.

The Spreckels Building, San Francisco. A 19-story steel-cage structure which withstood the earthquake of March 30, 1898, without injury. Gives illustrations of foundations and details of steel framework. 1600 w. Eng Rec—April 9, 1898. Serial. 1st part. No. 19475.

Towers.

Towers and Spires. George H. Blagrove. Part first deals with the foundations of towers. 2000 w. Ill Car & Build—April 8, 1898. Serial. 1st part. No. 19640 A.

HEATING AND VENTILATION.**Heaters.**

Instantaneous Water Heaters. Thomas D. Miller. Read at meeting of the Texas Gas and Electric Light Assn. Presenting the advantages of this appliance, with account of its construction and working. Also discussion. 3800 w. Am Gas Lgt Jour—April 18, 1898. No. 19637.

Hotel.

Steam Plant of the Astoria Hotel. Illustrated description of the 25,000 h. p. steam plant for heating and power purposes. 1800 w. Eng Rec—April 16, 1898. No. 19627.

Minneapolis Building.

Heating and Ventilation of the Wyman-Partridge Building, Minneapolis, Minn. Illustrated detailed description. 1200 w. Heat & Ven—April 15, 1898. No. 19739.

Piping.

Systems of Piping in Steam Heating. William Mansell. Read before the Toronto Chapter of Architects. Recounts some of the improvements and the general progress in this field. 2700 w. Can Arch—April, 1898. No. 19717 B.

Radiators.

Concerning Ribbed Heating Tubes. (Ueber Rippenheizkörper.) A discussion of the best proportions for ribbed or "extended" radiating surfaces to obtain the greatest amount of heat from the steam or hot water within. 1200 w. Gesundheits-Ingenieur—March 31, 1898. No. 19863 B.

Residence.

Heating a Country House. Describes the system in use at the residence of W. S. Opdyke, at Alpine, N. J. It is a combination of direct and indirect steam heating, a part of which is piped on the single-pipe system and a part on the two-pipe system. 1800 w. Met Work—April 2, 1898. No. 19352.

Testing.

A Preliminary Study of a Method of Testing Carbonic Oxid in the Atmosphere. (Etude préliminaire d'une Méthode de Dosage de l'Oxyde de Carbone Dilué d'Air.) A. Gautier. A contribution to the French Academy giving tests of very small quantities of carbonic oxid by the use of iodic anhydride. The reaction is shown to take place when the carbonic oxid is diluted with 30,000 times its volume of air. 2500 w. Comptes Rendus—March 28, 1898. No. 19822 D.

PLUMBING AND GASFITTING.**Bath.**

A Pittsburg Bath House. Illustrates a public bath with 22 rain baths and other less important fixtures. 700 w. Eng Rec—April 9, 1898. No. 19476.

See also Construction and Design.

Canada.

Plumbing Regulations in Canada. A copy of the regulations submitted by the sanitary committee of the Nat. Assn. of Master Plumbers of Canada. 3000 w. Dom Engng—April, 1898. No. 19616 C.

Hospital.

Plumbing in Lavatory Towers. Illustrates towers built against outside walls of an old hospital in New York, to furnish adequate lavatory facilities and ventilation. 1200 w. Eng Rec—April 23, 1898. No. 19731.

Ordinance.

Rock Island (Ill.) Plumbing Ordinance. An ordinance recently passed by the city council. 5000 w. San Plumb—April 15, 1898. No. 19777.

Stables.

Stable Plumbing. Illustrated description of the plumbing in the stable of M. F. L. Hungerford, New Britain, Conn. 1300 w. Met Work—April 16, 1898. No. 19612.

MISCELLANY.

Accounts.

Some Old Italian Building Accounts. William Scott. Some accounts of two or three centuries ago, giving an insight into methods used, cost of labor, materials, &c. 1300 w. Jour Roy Inst of Brit Archs—March 12, 1898. Serial. 1st part. No. 19504 B.

Casa Grande.

Repair of the Casa Grande Ruin, Arizona. Description with illustration of this work of aboriginal house-builders, for the preservation of which the U. S. Congress has appropriated a sum of money. 1800 w. Am Arch—April 23, 1898. No. 19733.

Chimneys.

Restoring the Verticality of Two Colliery Chimneys. M. Perrin. From a communication to the Société de l'Industrie Minérale. The work is described and its cost given. Ill. 1300 w. Col Guard—April 1, 1898. No. 19534 A.

Civic Architecture.

Civic Architecture from its Constructive Side. Charles Rollinson Lamb. The architectural development of New York, with suggestions and illustrations from numerous cities. Ill. 10000 w. Munic Af—March, 1898. No. 19556 C.

Columns.

A Straight Line Formula for Cast-Iron Columns. Samuel Osgood Miller. Gives diagram made from data obtained in tests made at Phoenixville, Pa., and Watertown, Mass. 900 w. Sch of Mines Quar—Jan., 1898. No. 19916 D.

Copyright.

Artistic Copyright. Georges Harmond. Read at meeting of the Roy. Inst. of Brit. Archts. Abstract of paper with editorial comment, and discussion. The protection of copyright in architectural design, as regarded on the continent of Europe. 4800 w. Builder—April 9, 1898. No. 19671 A.

Elevators.

Elevators in Private Houses. From the N. Y. *Evening Post*. The growing use of the elevator in private residences, with remarks on the design, motive power, cost, &c. 800 w. Arch & Build—April 9, 1898. No. 19477.

Gardening.

The City Garden. W. A. Langton. The importance to a building of the treatment of its site is discussed, and suggestions given. 3300 w. Can Arch—April, 1898. No. 19716 B.

Government Buildings.

Parliamentary Debate on the New Government Buildings. Reprint from the *London Times*. Deals with the expenses for new public buildings in London. Debate in the House of Commons. 4600 w. Brit Arch—March 25, 1898. No. 19378 A.

Hull, England.

The Architecture of our Large Provincial Towns. Illustrated description of the town and its architecture. 5500 w. Builder—April 2, 1898. No. 19559 A.

Inspection.

The Inspection of Buildings. Benjamin Franklin. Enumerates some points causing embarrassment in the application of the Building Inspection Law of 1893, and some of the instructive and interesting results from different methods and materials, with other information. Ill. 6000 w. Pro of Engs Club of Phila—March, 1898. No. 19446 D.

Light Rights.

Rights of Light and Other Easements. A. A. Hudson. Read before the Society of Architects, London. On the position of owners of property with regard to light and other easements, considering the possibility and advisability of legislation. 1500 w. Arch, Lond—April 1, 1898. No. 19543 A.

Monuments.

Preservation of Historical Monuments. Gives the law in France. 2000 w. Arch, Lond—April 8, 1898. No. 19664 A.

Preservation of Historical Buildings. Gives the regulations of the provincial commissions of historical monuments in Spain, which were approved Dec. 30, 1881. 1000 w. Arch, Lond—April 15, 1898. No. 19767 A.

Preservation of Historical Monuments. Information concerning the means adopted for the preservation of antiquities in Greece. 2000 w. Arch, Lond—April 1, 1898. No. 19544 A.

Preservation of Historical Monuments. Report on the legislation in Italy for preventing the destruction of historical buildings. 4500 w. Arch, Lond—March 25, 1898. No. 19375 A.

Nails.

The Holding Power of Nails in Douglas Spruce (Oregon Pine) and in Redwood (*Sequoia Sempervirens*). Frank Soule. Data obtained from tests made in the laboratory of the Univ. of California, in Berkeley, and conclusions drawn. 4200 w. Jour Assn of Eng Soc—Feb., 1898. No. 19361 C.

Painting.

Mural Painting. Edwin Howland Blashfield. Discusses the requirements of mural painting, its value as an educator, &c. 4800 w. Munic Af—March, 1898. No. 19558 C.

Renaissance.

English Renaissance Architecture. Reviews a work entitled "A History of Renaissance Architecture in England, 1500-1800," by Reginald Blomfield. 4000 w. Builder—April 16, 1898. No. 19766 A.

Revival.

The Possibilities of an Eighteenth-Century Revival. Arthur T. Bolton. Discusses the character of the architecture of this period, its limitations, &c., considering dulness an almost inseparable quality. 2800 w. Jour Roy Inst of Brit Archs—March 12, 1898. No. 19503 B.

CIVIL ENGINEERING.

BRIDGES.

American Bridges.

American Bridge Shop Practice. Editorial on the progress and the credit due the manufacturers, with a summary of prevailing practice and tendencies. 2700 w. Eng News—April 21, 1898. No. 19699.

Arches.

History of the Stone Arch. Malverd A. Howe. An interesting historical account, with illustrated descriptions of many ancient and modern structures in which the arch is used. 4200 w. Jour Assn of Eng Soc—Feb., 1898. No. 19363 C.

Rebuilding the Bridge of the Holy Cross over the Ill at Feldkirch in Vorarlberg. (Neubau der Gewölbten Heiligkreuzbrücke über den Ill-fluss bei Feldkirch in Vorarlberg.) Theodor Pawlik. A valuable paper describing the replacement of an old semi-circular arch by a flatter segmental structure, with all details of the computation, and erection. 10000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19348 D.

The Niagara Arch Bridge Swung. Describes the predecessors of this arch, the longest truss bridge on the continent. 700 w. Eng Rec—April 23, 1898. No. 19728.

The Niagara Arch. From data and prints furnished by Fred. W. Cohen. Treats of the novel points and method of erection. Ill. 3000 w. Stevens Ind—Jan., 1898. No. 19399 D.

The Niagara Railway Arch. R. S. Buck. Gives a historical review of former bridges on the site, and description of the present bridge with fine illustrations. 6300 w. Pro of Am Soc of Civ Engs—April, 1898. No. 19779 F.

Steel Arch Highway Bridge Over Fall Creek, Ithaca, N. Y. Illustrates and describes a bridge consisting of two plate-girder arch ribs braced together by cross-frames and a triangular lateral system, and carrying vertical latticed ports which uphold the floor system. 500 w. Eng News—April 28, 1898. No. 19790.

Buckling.

The Resistance to Buckling in the Vertical Members of a Truss Subjected to Unequal Loading. (Der Knickungs-Widerstand der Wandstabe eines Gitterträgers bei Ungleichmassiger Beanspruchung.) C. J. Kriemler. A graphical and analytical solution of this important problem in statics. 2000 w. Schweizerische Bauzeitung—Feb. 26, 1898. No. 19833 B.

Cincinnati Bridge.

The Newport and Cincinnati Bridge. Illustrated description of this 3,375-ft. structure, with 510 ft. channel span, which presents some unusual details owing to unsymmetrical loading. 400 w. Eng Rec—April 23, 1898. No. 19721.

Drawbridges.

Some Features of Draw or Rotating Bridges. Editorial explanation of recent failures of turntables. 700 w. Eng Rec—April 2, 1898. No. 19407.

Foundation.

The Foundation of the Right Pier of the Kornhaus Bridge at Berne. (Kornhausbrücke in Bern. Baugeschichte des Rechtfürigen Hauptpfeilers.) P. Simons. An account of the successful manner in which the pier for the great arch has been constructed in difficult ground on a steep slope. Two articles. 4500 w. Schweizerische Bauzeitung—March 26, April 2, 1898. No. 19835 each B.

Melan Bridge.

Construction of the Topeka Melan Bridge. Illustrates design and construction of a concrete-steel bridge with one span of 125 ft., two of 110 and two of 97.5. 2500 w. Eng Rec—April 16, 1898. No. 19623.

Paris Bridge.

The Bridge of Alexander III., at Paris. Illustrated description of a bridge being built across the Seine, and named for the Czar of Russia. 1000 w. Eng News—April 21, 1898. No. 19698.

Pier Moving.

Moving a Pier of the Bismarck Bridge; Northern Pacific R. R. An account of an important and difficult piece of work recently carried out under the direction of the engineering department of the Northern Pacific R. R. 800 w. Eng News—April 28, 1898. No. 19798.

Rock Island Bridge.

The New United States Rock Island Bridge. Illustrates particularly the details of swing span. 2600 w. Eng Rec—April 2, 1898. No. 19411.

Swing Bridge.

Proposed Design for Campbell Avenue Bridge Over Chicago Drainage Canal. A general description of the design of the superstructure, with illustrations showing the principal details, of plans prepared by the Sanitary District engineers. The plans were finally rejected, but of interest because of the completeness and magnitude of the scheme. 900 w. Ry & Engng Rev—April 23, 1898. No. 19762.

CANALS, RIVERS AND HARBORS.

Breakwater.

Breakwater at Presque Isle Point, Marquette, Michigan. W. H. Hoyt. Illustrated description of somewhat novel construction. 1000 w. Eng News—April 7, 1898. No. 19458.

Dam.

Steel Weir, Ash Fork, Ariz. Describes a dam 184-ft. long and 50-ft. deep, formed of steel frames faced with steel plates. Ill. 900 w. Eng Rec—April 9, 1898. No. 19470.

Danube.

The Completion of the Regulation of the Danube in Lower Austria. (Die Vollendung der Donau-Regulierung in Niederösterreich.) An official report upon the work from 1862 to the present time, especially with regard to the finan-

cial side of the question. 7000 w. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19845 D.

Dredging.

European Sea Going Dredges and Deep-Water Dredging. E. L. Corthell. The second paper discusses the conditions which justify dredging together with an account of the resultant commercial benefits. Many illustrations. 3500 w. Engineering Magazine—May, 1898. No. 19936 B.

Flow.

Surface Resistance of Water. H. S. Hele-Shaw. Read before the Inst. of Naval Arch'ts, London. Investigations of the nature of surface resistance of water and of stream line motion under certain experimental conditions. Ill. 2200 w. Engng—April 8, 1898. Serial. 1st part. No. 19645 A.

Jetty Construction.

Origin of the Gulf Stream and Circulation of Waters in the Gulf of Mexico, with Special Reference to the Effect on Jetty Construction. N. B. Sweitzer, Jr. Reviews the theories advanced regarding these currents, and gives conclusions from careful observations and from examination of the jetty construction upon the coasts of Texas and Mexico. Ill. 5400 w. Pro of Am Soc of Civ Eng—April, 1898. No. 19780 F.

Levee.

The Shawneetown Levee Disaster. Statement of two possible causes of this fatal accident. 800 w. Eng Rec—April 23, 1898. No. 19720.

Lighthouses.

A Contribution to the History of the Development of the Lighthouse. (Zur Geschichte und Entwicklung der Leuchtfeuer.) An address mainly historical and descriptive delivered by Constructor Veilmeyer before the Society of German Engineers in Berlin. 4000 w. Glaser's Annalen—April 1, 1898. No. 19840 D.

Lock Construction.

The Construction of Lock No. 1. Osage River, Missouri. F. B. Maltby. Illustrated description of the work and the interesting features of the lock. 2200 w. Eng News—April 28, 1898. No. 19797.

Mississippi.

Improvement of the Mouth of the Mississippi River. Thomas L. Raymond. Read before the Louisiana Engng. Soc. Reviews the conditions prevailing at or near the mouth and the methods which have been tried or suggested, and states the advantages of the jetty system. 4000 w. Eng News—March 31, 1898. No. 19314.

New York Canals.

Canal Improvement Postponed. Editorial on the situation in New York state, the legislature having refused to pass a bill to continue the work. 1600 w. Sea—April 7, 1898. No. 19505.

The Prospects of the New York Canals. Editorial discussion of this question and the importance of prompt action by the New York

legislature. 1800 w. Eng News—March 31, 1898. No. 19318.

Nicaragua Canal.

Some Engineering Features of the Nicaragua Canal. Alfred Noble. Describes the general features of the region, and gives an outline of the engineering features of the project. Also discussion and maps. 10000 w. Jour W. Soc of Eng—Feb., 1898. No. 19525 D.

Trench Machine.

A New Trench Machine. Illustrated description of a machine of the steel trestle type, put on the market by the Potter Mfg. Co. of Indianapolis. 500 w. Eng News—April 28, 1898. No. 19794.

IRRIGATION.

Central India.

Tank Irrigation in Central India. George Palmer. The second paper shows the arrangement of a typical series of tanks, with illustrations of tanks, weirs, and feeders. 3000 w. Engineering Magazine—May, 1898. No. 19942 B.

Gravitation.

Irrigation by Gravitation Channels from the Subsoil Water. J. E. Hilton. Showing that advantage can be taken of the high level at which the subsoil water stands in some of the submontane districts to convey the water by gravitation to the surface. Ill. 1800 w. Ind Engng—March 26, 1898. No. 19904 D.

MISCELLANY.

Anniversary.

The 50th Anniversary of the Society of Civil Engineers of France. (Le Cinquantenaire de la Société des Ingenieurs Civils de France.) A general historical notice in view of the coming celebration of the semi-centennial of the society. 1200 w. Moniteur Industrielle—April 9, 1898. No. 19876 G.

Carpentry.

The Deformation of Compression Members and the Stability of Large Wooden Frameworks. (Sur la Déformation des Pièces Comprimées et la Stabilité des Grande Charpentes.) A paper by M. Berard discussing the manner in which rupture takes place in wooden framework, based upon the work of deformation which occurs at the time of rupture. 1500 w. Comptes Rendus—April 4, 1898. No. 19824 D.

Cement.

Points on Portland Cement. Considers the chemical components, properties, uses, &c. 1800 w. Stone—April, 1898. No. 19701 C.

Slag Cement, its Production and Properties. (Der Schlackencement, seine Herstellung und Eigenschaften.) E. May. An exhaustive treatment of the methods of making cement from slag as practised in Germany, Austria, Belgium, France, and Russia, with data as to its properties and behavior under test. Two articles. 7500 w. Stahl und Eisen—March 1, April 1, 1898. No. 19850 each D.

Cement Testing.

Causes for the Variation in Cement Tests in

Different Places. (Ueber die Ursachen der Abweichungen in den Festigkeits-Ergebnissen der Cementprüfung an Verschiedenen Orten.) M. Gary. An exhaustive paper on the testing of cement and mortars, showing the number of variable elements which enter into the problem and affect the results. An important and valuable paper. 4000 w. Mitt aus d Kgl Tech Versuchsaustalt—Part I, 1898. No. 19866 G.

Cement Works.

Plant of the Milwaukee Cement Company. Frederick H. Lewis. Illustrates a natural rock cement mill with a capacity of 2800 barrels daily, and describes the Campbell kiln and Berthelet separating system. 2000 w. Eng Rec—April 2, 1898. No. 19410.

The New Plant of the Bronson Portland Cement Company, Bronson, Mich. Frederick H. Lewis. Illustrates and describes features of plant where European methods of handling clay and marl are combined with distinctive American practice of calcination. 3500 w. Eng Rec—April 30, 1898. No. 19955.

Columns.

See Architecture and Building, Miscellany.

Concrete.

Crushing Strength of Concrete with Various Aggregates. Gives results of tests of concrete made with same mortars but various proportions of stone and gravel. 1000 w. Eng Rec—April 9, 1898. No. 19473.

Drainage.

Note on Trellised Drainage in the Adirondacks. Albert Perry Brigham. Gives features of the drainage of this region, with map. 900 w. Am Geol—April, 1898. No. 19443 D.

Geology.

On the Relation of Geology to Engineering. Boyd Dawkins. The "James Forrest" lecture, delivered before the Inst. of Civil Engs., England. Considers questions that have been answered by the combined results of both sciences; the movement of water in the rocks, the deposition of superficial debris, the folds, &c. 3600 w. Engng—March 25, 1898. Serial. 1st part. No. 19388 A.

Roads.

Highway Improvement in Rhode Island. Description of state road construction. 1000 w. Eng Rec—April 16, 1898. No. 19622.

Tests of Road Materials. Editorial describing tests employed in Massachusetts and France to determine the relative values of stone for highway construction. 900 w. Eng Rec—April 23, 1898. No. 19718.

The New York Road Improvement Law. A statement of the provisions of the new State act. 800 w. Eng Rec—April 2, 1898. No. 19409.

Various Phases of the Road Question. Roy Stone. Considers questions of legislation, of public finance, and the forming of public opinion, methods and importance. Discussion. 8500 w. Pro Engs' Club of Phila—March, 1898. No. 19444 D.

Solar Transit.

A New Solar Transit. Illustrates and de-

scribes the operation of an instrument invented by J. B. Davis, which removes the difficulties usually met with in extending its use to land surveys. 1100 w. Eng News—April 28, 1898. No. 19796.

Strength of Wood.

The Relation of the Strength of Wood under Compression to the Transverse Strength. B. E. Fernow. Some of the results obtained from the study of wood and from extensive experiments. 1000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 19522 D.

Tachymeters.

The Cleps-Tachymeters. From "Guide pratique du Géomètre Moderne," by A. Salmoiraghi. Translated by C. McK. Lewis. Illustrated description of instrument and methods of use. Ill. 9500 w. Sch of Mines Quar—Jan., 1898. No. 19914 D.

Timber.

The Timbers of New South Wales. Abstract from the report of the government statistician, T. A. Coghlan, reviewing the timber products of the colony. 1100 w. Eng News—April 28, 1898. No. 19792.

Timber Suitable for Structures in Nicaragua and Costa Rica. Notes gathered from personal observation during residence of two years, and from writings of Spanish authors. 3000 w. Eng News—April 28, 1898. No. 19791.

Topography.

A Rapid Method for Plotting Contours. Emil L. Neubling. Illustrates method of dividing lines rapidly into a given number of parts. 400 w. Eng Rec—April, 1898. No. 19723.

Some Illustrations of the Influence of Geological Structure on Topography. Benjamin Smith Lyman. Calls attention to the relation between surface topography and the geological indications and the value in ascertaining the subterranean structure and economic importance. 1200 w. Jour Fr Inst—May, 1898. No. 19946 D.

Tunnelling.

The Use of the Shield in the Construction of Subways. (Emploi du Bouclier dans la Construction des Souterrains.) R. Godfernaux. A review of the work of M. Legouëz, with especial reference to the great Clichy collecting sewer. 5000 w. La Revue Technique—March 25, 1898. No. 19815 D.

The Use of the Shield in Subway Construction. (L'Emploi du Bouclier dans la construction des Souterrains.) R. Legouëz. Discussing the tunnel work of Brunel, Greathead, Berlier, and others, with the use of improved shield, including tables of rapidity of construction and cost of work for a number of cases. 3000 w. Le Génie Civil—March 19, 1898. No. 19801 D.

Tunnel Shields, Central London Railway. Describes special features of shields 12.5 and 22.8 feet in diameter used in tunneling clay and marl under 20 pounds air pressure. 800 w. Eng Rec—April 23, 1898. No. 19722.

Wheel.

A 360 foot Ferris Wheel. Illustrates the method of erecting a large wheel in Paris. 500 w. Eng Rec—April 23, 1898. No. 19727.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Africa.

The Commercial Importance of the Railway in German South-western Africa. (Ueber die Rentabilität der Deutsch-südwest-afrikanischen Eisenbahn.) A paper by Councillor Schwabe before the German Railway Society discussing the possible profitableness of the road, based upon the nature and products of the country, and showing the necessity of the greatest economy in construction if the interest on the cost is to be met. 7500 w. Glaser's Annalen—March 15, 1898. No. 19837 D.

American Trade.

The Advance of America's Foreign Trade. Editorial examination of the details of America's exports. 1500 w. Engng—April 8, 1898. No. 19643 A.

Bicycles.

Bicycle Trade in Foreign Countries. Reports on the trade in Denmark, Saxony, northern France, northern Spain, southern Italy and in Ontario. 2500 w. Cons Repts—April 8, 1898. No. 19463 D.

Brazil.

Brazil: Its Commerce and Resources. Thomas L. Thompson. Sets forth the resources, chief industries and commercial prospects of this country, and the rapid progress being made. 5700 w. Forum—March, 1898. No. 19491 D.

Central America.

Central America: Its Resources and Commerce. William Eleroy Curtis. Discusses the resources of the country and the causes for the failure of the republics to keep pace with the progress of the world in general. Interesting accounts of Guatemala and Salvador. 6000 w. Forum—March, 1898. No. 19494 D.

Chile.

New Chilean Customs Tariff. Statement of duties leviable under the new tariff. 5000 w. Bd of Trd Jour—April, 1898. No. 19784 A.

China.

Affairs in China. Remarks showing the general trend of events and their possible results on trade and industry. 2500 w. Engng—March 25, 1898. No. 19386 A.

China's Complications and American Trade. Clarence Cary. Considers the unfortunate condition of affairs in China, and the effect on trade. 4800 w. Forum—March, 1898. No. 19490 D.

New Trade Regulations in China. A translation of a communication from the Tsungli Yâmen, to the effect that goods sent inland under transit passes may be sold en route. 800 w. Cons Repts—April 7, 1898. No. 19433 D.

Competition.

American Competition and the Question of Transport. (Der Amerikanische Wettbewerb und die Frachtenfrage.) E. Schrödter. A paper before the convention of the *Verein Deutscher Eisenhüttenleute*, showing the important relation

which the cost of transport bears to the successful meeting of American competition in the iron trade. 7500 w. Stahl und Eisen—March 15, 1898. No. 19854 D.

Cuba.

The Foreign Commerce of Cuba. Showing the limitations imposed on Cuban foreign commerce, and the terrible results of the insurrection to the commercial interests of the island. 4800 w. Harper's Wk—April 9, 1898. No. 19455.

Exports.

Exports and Wages. Jacob Schoenhof. Considers the effect of wages on the export trade of a country, compares the exports of England and Germany, and studies the question of industrial prosperity in the United States. 4500 w. Forum—Jan., 1898. No. 19484 D.

Failures.

Failures Smaller Than for Four Years Past. Reports fewer business failures, smaller liabilities, and lessened assets of those failing, during the first quarter of this year, than in the corresponding periods of any year since 1893. 900 w. Bradstreet's—April 2, 1898. No. 19356.

Far East.

European Powers in the Far East. Editorial on affairs in the far east and a short synopsis of the concessions recently obtained from China. 2000 w. Engng—April 15, 1898. No. 19744 A.

The Markets of the Far East. Summary of replies to a letter of inquiry sent to leading exporters and importers, referring to general trade conditions. 1000 w. Cons Repts—April 20, 1898. No. 19686 D.

German Trade.

Development of German Trade in the Far East. Considers some of the facts relating to its growth. 700 w. Bd of Trd Jour—April, 1898. No. 19781 A.

Germany.

German Manufactures. Raphael - Georges Levy. Translated from *Revue des Deux Mondes*. A study of the recent progress, and the relation of German industry to the United States. 2500 w. Chau—May, 1898. No. 19910 C.

Hong Kong.

Foreign Competition in Hong Kong. Editorial on the effect on the condition of British trade of the present commercial and industrial movement. 2500 w. Engng—April 1, 1898. No. 19529 A.

Leather.

The German Leather Industry. States the preference for American dressed leather and shows that manufacturers have an opportunity to gain a permanent foothold. 600 w. Cons Repts—April 2, 1898. No. 19368 D.

New York Commerce.

The Decaying Commerce of New York and How to Restore it. Thomas C. Clarke. Discusses the work on canals in Canada, and the danger to New York commerce; and suggests

two routes which would enable New York to meet this competition. One connecting Lakes Erie and Michigan; the other the extension of the Ottawa route through Lake Champlain and the upper Hudson. 1600 w. Eng News—March 31, 1898. No. 19313.

Paris Exhibition.

The Paris Exhibition of 1900. Editorial on the conditions, privileges, and restrictions that will attend the admission of exhibits. 2500 w. Engng—April 15, 1898. No. 19742 A.

Permanent Exposition.

United States Warehouse in Venezuela. An account of the opening of the permanent exposition of American wares at Caracas, under the auspices of the Nat. Assn. of Mfrs. of the U. S. A. Addresses, extracts from press notices, &c. 4000 w. Cons Repts—April 18, 1898. No. 19641 D.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Showing fluctuations in quotations from July 1, 1895, to April 1, 1898. Also remarks on the check to rising prices due to unsettled conditions of foreign relations, and other causes. 3500 w. Bradstreet's—April 9, 1898. No. 19481.

Russia.

American Trade in Russia. Suggests some American articles that would find a market in Russia, gives information of how the competition of Germans in Russia is organized and other matters concerning trade. 1200 w. Ir Age—April 28, 1898. No. 19799.

Siam.

Trade and Trade Routes in Siam. Information of the trade of Siam, which is of importance because of its geographical position, giving values of exports and imports, and of the trading centers, &c. 2000 w. Bd of Trd Jour—April, 1898. No. 19782 A.

Tariff.

Tariff Changes and Customs Regulations. United Kingdom, Russia, Netherlands, Germany, France, Spain, Italy, Switzerland, Bulgaria, United States, Chile, British India, St. Lucia, Mauritius, Natal and Tasmania. 3800 w. Bd of Trd Jour—April, 1898. No. 19785 A.

The True Meaning of the New Sugar Tariff. Harvey W. Wiley. A review of the sugar tariff, making an attempt to explain the true meaning of the law. 4000 w. Forum—Feb., 1898. No. 19487 D.

Transportation.

The Improvement of Transportation in Country Districts. E. E. Russell Tratman. Read at meeting of the Illinois Soc. of Engs. & Surv. Discusses roads and their improvement, the building of a railway, &c. 2200 w. Brick—April, 1898. No. 19454.

Tunis.

British Trade with Tunis. Particulars taken from report of Sir H. H. Johnston, Consul-General at that place. 1600 w. Bd of Trd Jour—April, 1898. No. 19783 A.

War.

War and Business. Editorial considering the effect of war with Spain upon the business prosperity of the United States. 1500 w. R R Gaz—April 1, 1898. No. 19348.

West Indies.

The West Indies and Sugar Bounties. Nevile Lubbock. An account of the present condition of the West Indies, and a presentation of the case of sugar bounties, describing the effect which these bounties have had on the British colonies, Great Britain and the continent, and denouncing them. Discussion. 9500 w. Jour Soc of Arts—April 1, 1898. No. 19552 A.

CURRENCY AND FINANCE.

Bimetallism.

The Future of Bimetallism. G. G. Vest. Favoring bimetallism and discussing the position of the advocates of the gold standard. 2800 w. Forum—Jan., 1898. No. 19482 D.

Haitian Loan.

Haitian Loan Negotiations. Copy of a law passed by the last Legislature of Haiti for the purpose of negotiating a loan in the United States and for retiring the paper money. 3000 w. Cons Repts—April 13, 1898. No. 19577 D.

India.

Currency and the Money Market in India. Showing how the position is viewed in India, and describing the conditions which differ strikingly from those of England. 7000 w. Banker's Mag, Lond—April, 1898. No. 19497 B.

India on a Gold Basis. W. R. Lawson. An explanation of the currency question in India, and the crisis through which it is passing. 4800 w. Contemporary Rev—April, 1898. No. 19582 D.

GOVERNMENTAL CONTROL.

Swiss Railroads.

The Referendum and the Swiss Railroads. J. R. Macdonald. Republished from the *New Age*, London. An account of the railways of Switzerland and their purchase by the Government. 2000 w. Am Rev of Revs—April, 1898. No. 19351 C.

LABOR.

Arbitration.

Arbitration in Mining Disputes. Arbitration as controlled by English mining laws, giving cases. 2700 w. Col Guard—March 25, 1898. No. 19380 A.

Industrial Arbitration in Congress. Carroll D. Wright. An explanation of bill pending in Congress, showing how it differs from the law of 1888, and analyzing it. 4000 w. Gunton's Mag—April, 1898. No. 19500 C.

Credit Union.

The German Credit Union. Extracts from a paper by James G. Cannon, read before the Philadelphia Credit Men's Assn. 1600 w. Ir Age—April 7, 1898. No. 19436.

Factory Labor.

Factory Labor in the South. The conditions

existing in the south, and the need of changes. A reply to an article published in the *Atlanta Constitution*. 4800 w. *Guntton's Mag*—April, 1898. No. 19499 c.

Japan.

The First Railway Strike in Japan. Eli West. A brief account of the labor trouble and its outcome. 1000 w. *Ry Age*—April 22, 1898. No. 19735.

Labor Movement.

Women and the Labor Movement. M. E. J. Kelley. Presents the importance of bringing women to a knowledge of their social responsibilities and duties, discusses women as wage-earners, women of leisure, and the home-keeping women, and the influence of each class. 3800 w. *N Am Rev*—April, 1898. No. 19358 D.

Labor Question.

An Industrial Lesson. S. N. D. North. An examination of the causes of the English engineering strike and lock out, and a discussion of the strike and its outcome. 4500 w. *Ap Pop Sci M*—April, 1898. No. 19308 D.

Society Reports.

Steam Engine Makers' Society. The first report of the trade-union societies involved in the late strike, and containing much of interest on this subject, is discussed. 2500 w. *Engr*, Lond—March 25, 1898. No. 19389 A.

Strike.

The Coal Strike. Discussing some phases of the South Wales coal strike. 2500 w. *Engr*, Lond—April 15, 1898. No. 19752 A.

Trade Unions.

A Study in Trade Unionism. Benjamin Taylor. Discusses the methods of the unions as

brought out in the recent engineering strike and their present degrading influences. 7000 w. *Nineteenth Cent*—April, 1898. No. 19608 D.

Wages.

Wage Changes in England. Discusses statistics from the British Board of Trade reports. 1600 w. *Guntton's Mag*—April, 1898. No. 19501 c.

Working Class.

The Condition of the American Working-Class: How Can It Be Benefitted? Frank K. Foster. The labor problem and its perplexities are discussed. 5800 w. *Forum*—Feb., 1898. No. 19488 D.

The Incorporation of the Working-Class. Hugh McGregor. Reviews the struggles of the laboring classes, comparing the conditions of the present and past, and showing the progress of trades unions, and their effect on improving the conditions of the workers. 5500 w. *Forum*—Jan., 1898. No. 19485 D.

MISCELLANY.

Copyright.

See Architecture and Building, Miscellany.

Modern Industry.

Is There Work Enough for All? William T. Harris. The article deals with the needed readjustment of vocations, due to mechanical invention and changed conditions. 4400 w. *Forum*—April, 1898. No. 19495 D.

Sugar Industry.

Should the United States Produce its Sugar? James Wilson. Discussing whether it is a wise policy for the people of the United States to produce their own sugar; concluding in its favor. 3000 w. *Forum*—March, 1898. No. 19489 D.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Electro-Chemistry.

Some Notes on Electro-Chemistry. J. Wright. Historical review of early experiments in this industry, with description of some of the processes to which the art is applied. 3000 w. *Ind & East Engr*—March, 1898. No. 19681 D.

The Results of Organic Electro-Chemistry. (Die Erfolge der Organischen Elektrochemie.) Dr. M. Krüger. The beginning of a general review of the progress which has been made in the application of electrolysis to organic analysis. 2500 w. *Elektrochemische Zeitschr*—April 1, 1898. No. 19885 D.

Electrolysis.

Conductivity in Mixed Solutions of Electrolytes. (Ueber Stromleitung in Gemischten Lösungen von Elektrolyten.) K. Hopfgartner. Showing the influence which various proportions of mixed electrolytes have upon the results of electrolytic analysis. 3000 w. *Zeitschr f Elektrochemie*—April 5, 1898. No. 19883 H.

The Electro-Analytic Separation of Silver from a Nitric Acid Solution, and its Separation

from Copper. (Ueber die Elektro-Analytische Abscheidung des Silbers aus Salpetersaurer Lösung und die Trennung Desselben von Kupfer.) F. W. Kuster & H. von Steinwehr. Showing the results with different voltages and temperatures, and describing the methods employed. 2500 w. *Zeitschr f Elektrochemie*—April 5, 1898. No. 19884 H.

The Electrolytic Laboratory at the Imperial Mining Academy at Leoben. (Die Elektrolytische Einrichtung an der k. k. Bergakademie in Leoben.) Dr. H. Paweck. An account of the very complete apparatus at the Austrian Mining Academy for instruction in the application of electrolysis to the separation of metals. Two articles, 1 plate. 5000 w. *Oesterr Zeitschr f Berg u Hüttenwesen*—Feb. 19, 26, 1898. No. 19872 each B

Studies in the Electrolytic Reduction of the Nitro Group. (Studien über die Elektrolytische Reduktion der Nitrogruppe.) Walther Löb. Giving the methods and results of a valuable series of experiments in the electrolytic reduction of the nitro organic compounds. 6000 w. *Zeitschr f Elektrochemie*—March 20, 1898. No. 19882 H.

Electro-Metallurgy.

Notes on the Moebius Processes for Parting Gold and Silver, as Carried on at the Guggenheim Smelting Works at Perth Amboy, N. J. Percy Butler. The processes of this establishment are described as all are dependent on one another. The plant is described and illustrated. 4500 w. Can Min Rev—March, 1898. No. 19374 C.

Electro-Plating.

Electrical Equipment of Plating Plants. C. F. Burgess. Comments on the fact that this branch of electrical industry has not shared the rapid development of other electrical industries, and reviews the work, offering suggestions and conclusions. 3300 w. W Elect'n—April 2, 1898. No. 19425.

The Electroplating of the Dome of the Philadelphia City Hall Tower. Abstracted from a paper read before the Engineers' Club of Philadelphia by Francis Schumann. The electroplating had to cover some 120,000 sq. ft. of surface, and included pieces weighing about 10,000 lbs. each. It required nearly fifty months of actual time, working both day and night. 1000 w. Elec Wld—April 16, 1898. No. 19589.

LIGHTING.**Electric Lamp.**

The Welsbach Electric Lamp. Concerning the latest invention of Dr. C. Auer von Welsbach. 1700 w. Jour Gas Lgt—April 19, 1898. No. 19908 A.

English Plants.

Statistics on English Electric Lighting Plants. Claud P. D'Oyly. Part first states the present conditions in England and some of the results of operation of various plants. 1800 w. Elec Eng, N. Y.—April 14, 1898. Serial. 1st part. No. 19575.

Lamps.

Two-Hundred Volt Lamps. Editorial on the change from 100 to 200-volt lamps in England, and giving conclusions from the discussion of Bingswanger Byng's paper before the Inst. of Elec. Eng. 1500 w. Engng—March 25, 1898. No. 19383 A.

Municipal Lighting.

The Commercial and Business Aspects of Municipal Electricity Supply. Alfred H. Gibbins. Discussing what has been attempted or accomplished toward increasing the advantages for consumers and at the same time reducing costs, with related matters of interest. 2200 w. Elect'n, Lond—April 8, 1898. Serial. 1st part. No. 19662 A.

Photometry.

Station Photometry. Buckner Speed. Detailed directions for the construction and operation of a central station photometer department. 3000 w. Elec Wld—April 9, 1898. No. 19451.

Rates.

Rates for Electric Lighting. E. L. Wells, Jr. Read before the Texas Gas and Elec. Lgt. Assn. Discusses the advantages and disadvantages of the various systems. Also discussion by

members. 6200 w. Am Gas Lgt Jour—April 25, 1898. No. 19737.

Sign Switching.

Electrical Sign Switching. George T. Hanchett. Shows a few expedients in sign manipulation that have cheapness and adaptability to recommend them. Ill. 1400 w. Am Elect'n—April, 1898. No. 19448.

Torquay Works.

Torquay Municipal Electricity Works. Illustrated description of a high pressure alternating current supply system. 2000 w. Elec Rev, Lond—April 1, 1898. No. 19542 A.

POWER.**Accumulators.**

Fribourg Accumulator Plant. Describes and illustrates a plant in Switzerland. 900 w. W Elec—April 2, 1898. No. 19424.

Some Recent Improvements in Accumulators and Their Application to Traction on Common Roads. J. T. Niblett. Abstract of a paper read before the Self-Propelled Traffic Assn., Liverpool Centre. Deals especially with propulsion by means of batteries, the recent improvements, how best employed, &c. 1800 w. Elec Rev, Lond—April 8, 1898. Serial. 1st part. No. 19669 A.

Cranes.

See Mechanical Engineering, Shop & Foundry.

Electrical Energy.

The Cost of Generation and Distribution of Electrical Energy. R. Hammond. Abstract of paper read before the Inst. of Elec. Eng., London. Facts from the official returns of electric supply works. 2000 w. Col. Guard—April 1, 1898. No. 19535 A.

Electric Plant.

The Plant of the Ellicott Square Building. F. L. Wilson. Illustrates and describes the mechanical and electrical plants of this large building in Buffalo, N. Y. 3500 w. Elec Wld—April 30, 1898. No. 19787.

Electric Power.

Matters Affecting the Cost of Electric Power. H. P. Elliott. Digest of a paper showing the great influence of the variable load upon the cost, and the relation of the various items that enter into the cost of production. 1600 w. Can Elec News—April, 1898. No. 19506.

Electricity in Ships.

See Marine Engineering.

Electric Transmission.

The Electric Transmission of Water Power. William Baxter, Jr. Presents examples of electrical transmission of water powers to distant points where they can be utilized, showing that it has passed far beyond the experimental stage. Also considers the results that may follow. Ill. 3800 w. Ap Pop Sci M—April, 1898. No. 19309 D.

Fan Motors.

Fan Motor Problems and Some of Their Solutions. Technical description of many of the various makes of fan motors. Ill. 3000 w. Elec Wld—April 2, 1898. No. 19332.

Generators.

The Determination of the Size and Number of Turns of Wire in a Constant Potential Generator. William Baxter, Jr. Shows how to develop a practically constant pressure and explains the principles upon which the winding of constant potential generators depend. 2000 w. Am Mach—April 14, 1898. No. 19585.

Motors.

Alternating-Current Motors. E. E. Tasker. Read at the students' meeting of the Inst. of Elec. Eng., London. Illustrated explanation of the working of an alternating-current generator and motor, and the various devices used. 4000 w. Elec Eng, Lond—April 1, 1898. Serial. 1st part. No 19549 A.

The Determination of the Size and Number of Turns of Wire in a Constant Speed Motor. William Baxter, Jr. Considers the principles of operation and the winding of the wire of a constant speed motor. Diagrams. 2000 w. Am Mach—March 31, 1898. No. 19311.

The Regulation and Protection of the Electric Motor. Harry H. Cutter. Paper read before the Chicago Elec. Assn. Discusses various methods for the regulation of motors and the means of properly protecting from damage. 4800 w. Elec, N. Y.—April 13, 1898. No. 19581.

Polyphase Circuits.

Three-Phase Machinery. William Mayo Venable. Facts about polyphase circuits with description of types of three-phase machinery. Ill. 1600 w. W Elect'n—April 9, 1898. No. 19563.

Power Plant.

Power Plant with Electric Transmission at Delta, Pa. S. R. Stubbs. A short description of a small but interesting plant. 900 w. Eng News—April 21, 1898. No. 19695.

The Hydro-Electric Power Plant of Grenada, Spain. (Usine Hydro Electrique de Grenade.) R. B. Ritter. An extended account of this important plant. A fall of 100 meters is utilized to obtain 1750 h. p. from the Rio Genil. 3500 w. 1 plate. Le Génie Civil—April 2, 1898. No. 19806 D.

The Helena Power Development. Illustrates plant on the Missouri River for developing 10,000 h. p. 1200 w. Eng Rec—April 16, 1898. No. 19626.

See Mechanical Engineering, Power and Transmission.

Shop Power.

See Mechanical Engineering, Shop & Foundry.

Storage Batteries.

The Electric Storage Battery Co.—Its Factory and Its Battery Installations. Joseph Wetzler. An account with many illustrations, of the factory and methods of manufacture of this company and some of the plants installed. 9900 w. Elec Eng, N. Y.—April 28, 1898. No. 19771.

Tanneries.

Electrical Transmission in Tanneries. An account of a number of tanneries which have been electrically equipped. Ill. 2300 w. Elec Eng, N. Y.—April 7, 1898. No. 19428.

Transformers.

Lowering Transformers for Niagara Power. J. S. Peck. Illustrated description of the large transformers recently furnished the Cataract Power & Conduit Co. of Buffalo, N. Y., and the method of regulation employed. 2000 w. Elec Wld—April 9, 1898. No. 19450.

The Efficiency of the Alternating Current Transformer. Alexander Russell. Describes a graphical method of finding the efficiencies of a transformer at all loads which is simple and gives accurate results. 1700 w. Elect'n, Lond—March 25, 1898. No. 19398 A.

Transmission.

A 1000 Horse Power High Voltage Transmission Experiment at Ogden, Utah. Describes an interesting experiment made to ascertain the limits within which high voltage currents might be used commercially. 600 w. Elec Eng, N. Y.—April 28, 1898. No. 19772.

The Pioneer Electric Power Transmission. Illustrated description of the transmission plant for utilizing the water power of Ogden Canyon, Utah. 4200 w. Jour of Elec—March, 1898. No. 19426.

See Electrical Engineering, Power.

TELEGRAPHY AND TELEPHONY.**Cable Capacity.**

Notes on the Ballistic Determination of the Capacity of Coiled Cables. Arthur Dearlove. Discusses "double-ending" the cable, and the satisfactory results, giving details of experiments made. 900 w. Elect'n, Lond—April 8, 1898. No. 19661 A.

Electric Arc.

The Electric Arc as a Telephone. Reports some curious experiments, described by Hermann Th. Simon, in *Wied. Ann.*, which show that the electric arc is capable of acting either as a telephone transmitter or as a receiver. 500 w. Elec Rev, Lond—March 25, 1898. No. 19395 A.

Inductance.

Inductance in Telephony. W. Moon. Deals with inductance effects apart from capacity. 700 w. Elec Rev, Lond—April 15, 1898. Serial. 1st part. No. 19769 A.

Recorder.

The First Telegraph Recording Register. Illustration and statement concerning the first telegraph recording register on which was received the first message, with copy of agreement between S. F. B. Morse and Alfred Vail. 1200 w. Elec Rev, N. Y.—April 27, 1898. No. 19773.

Space Telegraphy.

Experiments with Spark Telegraphy. K. Strecker. Abstract of a paper read before the *Elektrotechnischer Verein*. Describes an experiment with the Hughes type-printer, and improved connections for Morse instruments. Ill. 800 w. Elect'n, Lond—April 8, 1898. No. 19663 A.

Hertz Wave Signalling in War. Charles T. Child. Shows that this method of communication is not yet ready for service as a military.

auxiliary. 900 w. Elec Wld—April 30, 1898. No. 19789.

Telegraphy Across Space. Silvanus P. Thompson. A lecture giving an excellent explanation of this subject, discussing conduction methods, induction methods, and wave methods. 5400 w. Jour. Soc of Arts—April 1, 1898. No. 19553 A.

The New Telegraphy. A. Slaby. Gives recent experiments in telegraphy with sparks, showing also the shortcomings and weaknesses of the system, but regarding the subject hopefully. Ill. 4500 w. Century Mag—April, 1898. No. 19336 D.

Wireless Telegraphy. Illustrates and explains the apparatus designed by W. J. Clarke, of the United States Electrical Supply Co., of New York, suitable for the requirements of wireless telegraphy. 1200 w. Sci Am—April 2, 1898. No. 19325.

Telautograph.

Locating Submarine Mines by Means of the Telautograph. Editorial on an article in the Chicago *Times-Herald* in which Prof. Elisha Gray describes an ingenious arrangement by which the telautograph could be adapted for locating the exact position of an enemy's vessel. 1200 w. Elec, N. Y.—April 13, 1898. No. 19580.

Telephone.

How to Select a Telephone. H. P. Clausen. Discussion of this subject and of the work intended to be done by the apparatus. 2200 w. W Elect'n—April 9, 1898. No. 19565.

Telephone Exchange.

The Independent Telephone Exchange at La Crosse, Wis. J. R. Cravath. Illustrated description. 1100 w. Elec Eng, N. Y.—April 14, 1898. No. 19574.

The John Street Exchange of the New York Telephone Company. Information concerning an exchange recently put in service in New York. 1600 w. Elec Wld—April 16, 1898. No. 19588.

Telephone Lines.

Locking and Unlocking Devices on Party Telephone Lines. H. S. Webb. Illustrated description of the mechanism for locking all the telephone switches except the one called up by the exchange operator, and then for unlocking them all when the line is free. 900 w. Elec Wld—April 16, 1898. No. 19587.

Telephone Plant.

The New Bell Telephone Plant in St. Louis, Mo. Fred. E. Bausch. Describes and illustrates a complete modern conduit system and underground service, with building and plant. 4400 w. Elec Eng, N. Y.—April 21, 1898. No. 19682.

Zurich Fire.

Fire at the Central Telephone Station of Zurich. C. Du Riche Preller. Gives an account of unusual and very remarkable circumstances which caused the fire, and the destruction which in the station alone is estimated at one million francs. 1000 w. Engng—April 8, 1898. No. 19644 A.

MISCELLANY.

Club House.

The Electrical Equipment of the New York Athletic Club House. Illustrated description of the electrical and mechanical equipment, with criticisms. The building is located at the south-east corner of Sixth avenue and Fifty-ninth street. 2200 w. Elec Wld—April 16, 1898. No. 19586.

Electrical Education.

Electrical Engineering at Columbia University. Francis B. Crocker. Brief illustrated description of the new engineering building, and the fine facilities for study in the various branches. 3000 w. Sch of Mines Quar—Jan., 1898. No. 19915 D.

Electrical Industry.

Through English Eyes. Notes on electrical manufacture in the United States, giving an account of visits to various works. 1500 w. Elec Rev, N. Y.—April 20, 1898. No. 19683.

Electrical Progress.

Electrical Advance in the Past Ten Years. Elihu Thomson. Interesting review of the great progress in the electrical industries, and in the science of electricity. 6000 w. Forum—Jan., 1898. No. 19483 D.

Electric Furnace.

The Electric Furnace. John Trowbridge. Reviews some of the processes affected by the electric furnace, and its great advantage over other furnaces in its power to localize the heat in a narrow compass. 2000 w. Chau—May, 1898. No. 19911 C.

See Mining and Metallurgy, Iron and Steel.

Insulation.

Experiments on the Disruptive Strength of Insulating Materials. Charles P. Hidden and Olaf M. Kelly. Graduation thesis. Gives results of a series of experiments made to measure as accurately as possible the electric pressures required to disrupt specimens of common insulating materials under conditions similar to those encountered in practice. 2200 w. Stevens Ind—April, 1898. No. 19713 D.

Insulation and Conduction. Reginald A. Fessenden. Read before the Am Inst of Elec Engs. Gives an account of the manner in which the current passes through materials, and discusses the purposes for which insulation is used, and the substances best suited to each case. 3300 w. Elec Wld—April 2, 1898. No. 19324.

Magnets.

On the Temperature Coefficients of Certain Seasoned Hard Steel Magnets. Arthur Durward. Reports a series of experiments on a large number of glass-hard magnets made of different kinds of steel and carefully seasoned. Tabulated results. 2000 w. Am Jour of Sci—April, 1898. No. 19343 D.

Meter.

New Electric Meters. (Neuer Elektrizitäts-zähler.) A description of the electricity meter of Dr. H. Aron; an electric pendulum and escapement system is used. 1200 w. Elektrotech Rundschau—April 15, 1898. No. 19880 B.

Oscillatory Currents.

Oscillatory Currents and Some of Their Phenomena. E. F. Northrup. Describes the general methods and the construction of the necessary apparatus for obtaining oscillatory currents and their effects. 3800 w. Elec Wld—April 30, 1898. Serial. 1st part. No. 19788.

Potential.

The Graphical Method of Representing Alternating Potentials. (Ueber die Graphische Darstellung des Wechsellpotentials und ihre Anwendung.) H. Görges. An elaborate geometrical system of showing alternating potentials, describing the method of application. 5000 w. Elektrotechnische Zeitschr—March 17, 1898. No. 19887 B.

Rotating Fields.

The Production of Rotating Fields by Foucault Currents. (Ueber die Entstehung Rotirender Magnetfelder durch Foucaultströme.) F. Braun. Describing the apparatus used for producing rotating fields and also the methods for examining them. 2500 w. Elektrotechnische Zeitschr—March 31, 1898. No. 19890 B.

Thermometry.

The Determination of Low Temperatures. (Die Bestimmung Tiefer Temperaturen.) G. W. Meyer. Describing an electrical method based on the diminution of electrical resistance with reduction in temperature. 2000 w. Elektrotechnische Zeitschr—April 1, 1898. No. 19886 D.

MARINE ENGINEERING.**Cargo Steamers.**

The Designing of Cargo Steamers. Aragh E. Long. Abstract of paper read at the meeting of the North-East Coast Inst. of Engs. & Shipbuilders, at Newcastle-on-Tyne. Considers dimensions, form, and other questions. 2000 w. Steamship—April, 1898. No. 19551 A.

Copper Pipes.

Brazed Copper Steam Pipes. Editorial on the accident to the steam pipe of the Prodano, and the investigations recently made by Prof. Arnold, for the committee of Lloyd's Register of British and Foreign Shipping. 1700 w. Engng—April 15, 1898. No. 19743 A.

The Failure of Copper Steam Pipes. Remarks of the chief engineer surveyor of Lloyd's Register of British and Foreign Shipping, respecting Prof. Arnold's report on the exploded steam pipe of the ss. Prodano. 4800 w. Engr, Lond—April 15, 1898. No. 19753 A.

Cymric.

New White Star Freight and Passenger Transatlantic Liner Cymric. Brief illustrated description of the largest freight steamship afloat. 700 w. Marine Engng—April, 1898. No. 19510 C.

Ferry Steamers.

Ice Crushing and Ferry Steamers at the Straits of Mackinac. W. D. Hulbert. Illustrated description of vessels built by the Detroit Dry Dock Co. for winter navigation through fields of heavy ice. 1300 w. Marine Engng—April, 1898. No. 19512 C.

Foundering.

The Foundering of the Japanese S. S. Tai Hoku. Cecil Lightfoot. Letter giving an account of the catastrophe and four snapshot photographs. 1400 w. Ind & East Engr—March, 1898. No. 19680 D.

Great Lakes.

The Great Lakes and the Modern Navy. J. H. Gibbons. Shows that the development of the iron and steel industry of this region of the United States has an important effect on shipbuilding; discusses the projects to connect the

lakes with sea by improvements in canals, and the result this would have on our merchant marine, &c. 4000 w. N Am Rev—April, 1898. No. 19359 D.

Marine Engines.

Reminiscences of Early Marine Steam Engine Construction and Steam Navigation in the United States of America from 1807 to 1850, Charles H. Haswell. Read at meeting of the Inst. of Naval Archts., London. Historical account of types used and general progress in construction and design. 3300 w. Engr, Lond—April 1, 1898. No. 19540 A.

Maritime Congress.

The Congress of the Technical Maritime Association (Congres de l'Association Technique Maritime.) M. Hachebet. A general report of the convention recently held at Paris, with brief abstracts of the more important papers presented. 1500 w. Le Génie Civil—April 2, 1898. No. 19807 D.

Paddle Wheels.

Paddle Wheels. A. S. Mills. Read at meeting of the Bristol Channel Centre of the Inst. of Marine Engs., at Cardiff. Abstract of paper and discussion. Discusses the early forms of these wheels and their development. 2800 w. Steamship—April, 1898. No. 19550 A.

Propelling Machinery.

The Engines of the French Cruiser Brennus. Camille Roche. Abbreviated description from the *Revue de Mécanique*, with illustrations. 700 w. Engr, Lond—April 1, 1898. Serial. 1st part. No. 19536 A.

Raising Vessels.

The Waller Tube for Raising Sunken Vessels. Ernest A. Sjöstedt. Describes the apparatus invented by P. A. Waller, a Swedish engineer, as exhibited at the Stockholm Exposition. The "Södra Sverige," a vessel raised by this method from a depth of some 183 ft. was also exhibited. 1500 w. Ir Age—April 7, 1898. No. 19438.

Sailing Vessels.

The Future of the Sailing Ship. Editorial on

the economical causes of the collapse of this industry in Great Britain. 1700 w. Engr, Lond—March 25, 1898. No. 19391 A.

Sheathing.

On the Direct Attachment of Copper Sheathing Plates to the Hulls of Vessels. Leopold Roper. Read at session of the Inst. of Naval Arch'ts., England. Describes Roper's system of coppering steel ships, which the writer claims approaches nearer to the ideal than any other known system. 2500 w. Ind & Ir—April 15, 1898. No. 19757 A.

Southern Ports.

New Orleans and Galveston. Considers the improvements, and their growing importance in the export business. 1500 w. Transport—April 1, 1898. No. 19547 A.

Steamship Communication.

Steamship Communication Between New York and Buenos Ayres. Presents the conditions to be considered under existing American law, in establishing a fortnightly fast mail service between these ports. 3000 w. Cons Repts—April 12, 1898. No. 19566 D.

Tonnage.

Tonnage and Its Measurement. Refers to Mr. Ramage's paper on "Minimum Net Register and its Effect on Design," and to Mr. W. Hök's paper on "The Trunk-Deck Steamer Oscar II," and the exposure of tonnage cheating. 2500 w. Engr, Lond—April 15, 1898. No. 19750 A.

Trunk Steamer.

Trunk Deck Steamer "Oscar II." W. Hök. Read before the Inst. of Naval Arch'ts., England. States the principles which form the

basis for the construction of trunk-deck vessels, showing the differences between this type and ordinary vessels, giving particulars of the steamer named. Ill. 3800 w. Engng—April 15, 1898. No. 19741 A.

Twin-Screws.

Experiments on the Effect of Direction of Turning in Twin-Screws. R. E. Froude. Read before the Inst. of Naval Arch'ts. Gives results of model experiments on the comparative efficiency of the two directions of turning. 1200 w. Engng—April 1, 1898. No. 19531 A.

Valve Gear.

Single-Eccentric Valve-Gears for Marine Engines. (Beitrag zur Praktischen Konstruktion der Einexzeuter-Umsteuerungen für Schiffsmaschinen.) Von Berling. A general investigation of the so-called "radial" valve gears, including nearly every variety used in marine practice; with valve diagrams and illustrations of constructive details. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—April 2, 9, 1898. No. 19829 each D.

Yacht.

Details of Construction of the Twin-Screw Steam Yacht Niagara. Information and exact data concerning this fine vessel being built for Howard Gould, of New York. Ill. 1200 w. Marine Engng—April, 1898. No. 19511 C.

Yashima.

The Steering Qualities of the Yashima. Philip Watts. Read at session of Inst. of Naval Arch'ts., England. Reports a series of turning trials. 1400 w. Engr, Lond—April 15, 1898. No. 19754 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Test.

Test of a Vertical Boiler. George H. Barus. Tested while running under ordinary service conditions. 600 w. Eng Rec—April 2, 1898. No. 19416.

Bracing.

Bracing Boiler Heads. An article prepared in compliance with a request for tables for calculating the number of braces required in staying boiler heads, when the braces are an inch and one-eighth in diameter. 1200 w. Locomotive—March, 1898. No. 19629.

Evaporation.

Evaporation. W. N. Twelvetrees. Extract from a paper before the mechanical engineers of London, Eng., on the theory and practice. 800 w. Bos Jour of Com—April 23, 1898. No. 19732.

Feed Water.

Heating Feed-Water. Editorial giving history of this discovery, and discussing the problem. 1500 w. Engr, Lond—April 8, 1898. No. 19659 A.

Furnaces.

Refractory Furnace Surfaces. W. H. Booth. Gives the writer's views on the importance of refractory lining and the faults in the present system of firing. 1200 w. Am Mach—April 28, 1898. No. 19927.

Oil Fuel.

Oil Fuel for Steam Generators. A. M. B. Describes apparatus designed to meet the conditions of supplementary service. Ill. 2400 w. Ry Wld—April 7, 1898. No. 19639 A.

Water-Tube Boilers.

Description of Some Experiments with a Water-Tube Boiler. A. F. Yarrow. Describes some experiments made last year, and shows the advantage of the new feed system. Ill. 1800 w. Engng—April 1, 1898. No. 19530 A.

The Use of Water-Tube Boilers in Steel and Iron Works. John Jardine. From a paper read before the West of Scotland Iron and Steel Inst. The demand for higher pressures and the economy to be effected by the use of these boilers; their safety and the possibility of utilizing the waste heat. 2200 w. Col Guard—April 15, 1898. No. 19748 A.

Working Results with Belleville Boilers in Twin S. S. Kherson. G. Gretchin. Abstract of "Notes" communicated to the Inst. of Engs. & Shipbuilders in Scotland, with editorial. A record of personal experience and observation. 5300 w. Engr, Lond—April 1, 1898. No. 19538 A.

COMPRESSED AIR.

Air Transmission.

Practical Application of High Range Compressed Air Power Transmission. Frank Richards. Describes the machine and the system by which the compressor receives the air returning from whatever it is employed to drive, and compresses it to a still higher pressure, sending it out again to do more work. Ill. 1800 w. Am Mach—April 28, 1898. No. 19929.

Compound Compressors.

The Proportions of Compound Air Compressor Cylinders to Secure Best Economy.—Economy of Compounding. F. A. Halsey. Demonstrates that the proportion of cylinders which divides the work equally also secures the greatest saving possible from compounding. 1500 w. Am Mach—March 31, 1898. No. 19310.

Compressed Air.

See Military Engineering.

Liquefied Air.

Liquefied Air. Sol. D. Benoliel. Gives an account of the work of Charles Tripler, with references to the patents of Dr. C. Linde, of Germany, and W. Hampson, of England, and describes investigations of the properties. 1800 w. Elec Eng, N. Y.—April 14, 1898. No. 19576.

Liquid Air. Walter H. Dickerson. Remarks on conditions necessary for reducing gases to the liquid state, with explanation of the process of Charles E. Tripler and description of interesting experiments. 4800 w. Stevens Ind—April, 1898. No. 19715 D.

Liquid Air. W. C. Peckham. Describes three methods of measuring low temperatures, giving experiments. 1200 w. Sci Am—April 23, 1898. No. 19694.

Liquid Air as a Blasting Explosive. J. A. Ewing. Extract from a paper read before the Society of Arts, London, on "Linde's Method of Producing Extreme Cold and Liquefied Air." Refers to its use as an explosive by mixing it with carbon. Ill. 1800 w. Col Guard—March 18, 1898. No. 19642 A.

The Commercial Manufacture of Liquid Air. An account of the methods by which liquid air is now manufactured with ordinary commercial apparatus and at a comparatively small cost. Describes apparatus used by Chas. E. Tripler. Also editorial. 4000 w. Eng News—April 14, 1898. No. 19598.

Pneumatic Machinery.

Pneumatic Machinery for Loading and Discharging Grain Cargoes. Frederic Eliot-Duckham. Read at meeting of Inst. of Naval Arch'ts., London. Reviews the increase in trade and the changed conditions making improvements important, and gives illustrated de-

scription of pneumatic elevators now in successful operation. 1700 w. Engr, Lond—April 8, 1898. No. 19650 A.

Refrigeration.

Mechanical Refrigeration by Use of Compressed Air. Leicester Allen. A clear explanation of the mode of cooling by compressed air, and the cause of failure from wrong application. Covers the entire cycle of operations and changes in the process. 3000 w. Am Mach—April 21, 1898. No. 19689.

ENGINES AND MOTORS.

Balancing.

The Balancing of Engines. James Whitcher. Read before the Manchester (Eng.) Assn. of Engs. Treats the subject in an explanatory manner, showing on what the science of balancing is founded, discussing the effect of the balancing effort upon the bearing pressures, the balancing proper of engines, &c. 4000 w. Ind & Ir—March 25, 1898. Serial. 1st part. No. 19394 A.

Breakdown.

Accident to a Steam Engine. (Unfall an einer Dampfmaschine.) O. Meyerhoff. A description with illustrations, of the breakdown of a tandem Corliss engine at Widzew near Lodz, Poland. The intermediate piston rod broke, causing much damage; the constructive defects which led to the accident are discussed. 1500 w. Zeitschr d Ver Deutscher Ing—April 9, 1898. No. 19831 D.

Calorimeters.

Steam Calorimeters. A. H. Eldredge. Treats of their construction, value and use to the engineer. Ill. 1600 w. Mach, N. Y.—April, 1898. No. 19355.

Engine Tests.

Test of Grosvenordale Compound Engine With and Without Jackets. G. H. Barrus. An elaborate article showing action of jackets. 1500 w. Eng Rec—April 16, 1898. No. 19625.

Furnace Gas.

The Application of Blast Furnace Gases for Direct Power Generation. (Verwendung der Hochofengase Zur Unmittelbaren Krafterzeugung.) F. W. Lürmann. A paper presented at the Düsseldorf convention of the Verein Deutscher Eisenhüttenleute with discussion. The practical difficulties are dealt with, and points from the limited experience available are given. 10000 w. Stahl und Eisen—March 15, 1898. No. 19853 D.

The Utilization of Blast Furnace Gas in Gas Engines. F. W. Lürmann. Condensed translation of a paper read before the general meeting of the Verein Deutscher Eisenhüttenleute. Part first deals with the efficiency of the gas engine, and the dust contained in furnace gases. 2500 w. Am Mfr & Ir Wld—April 8, 1898. Serial. 1st part. No. 19508.

Gas Engines.

Combustion Motors with High Compression. (Moteurs à Combustion et Haute Compression.) A paper by M. Wilz, discussing especially the theories of Diesel, in connection with the high compression used with the Diesel motor. 1000

w. Comptes Rendus—March 28, 1898. No. 19823 D.

Critical Notes on the Theory and Construction of Rec nt Gas Engines. (Kritische Bemerkungen über die Theorie und Bauart der Neueren Gaskraftmaschinen.) G. Wellner. A review of the theories advanced by Diesel, with especial regard to the compression of the gas and air separately. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—March 25, 1898. No. 19842 B.

Gas and Oil Engines. Thomas L. Wilkinson. Read before the Colorado Scientific Soc. in Denver. Part first considers the original Otto gas engine, comparing it with the modern Otto, noting the advancement. 2400 w. Am Mfr & Ir Wld—April 1, 1898. Serial. 1st part. No. 19405.

Governor.

Governor with Electric Brake. (Régulateur à Frein Electrique.) Rieter's improved governor is especially adapted for use with hydraulic motors, and utilizes the retarding action of an electric current upon a revolving mass of iron to assist in the regulation of the speed. 1000 w. Le Génie Civil—March 19, 1898. No. 19802 D.

Shaft Governor with Relieved Connections. (Achsenregler mit Entlasteten Gelenken.) O. Franiek. An improved shaft governor in which knife-edge bearings are used, in order to avoid the disturbing influence of friction in the pin connections. 1200 w. Zeitschr d Ver Deutscher Ing—March 19, 1898. No. 19826 D.

Steam Economy.

The Economical Use of Steam in Non-Condensing Engines. James B. Stanwood. A discussion of the conditions under which the use of a fixed point of cut-off and throttling governor may be preferable to automatic cut-off. 3500 w. Engineering Magazine—May, 1898. No. 19935 B.

Steam Engines.

An Historical Chapter on the Steam Engine. Traces from B. C. down to the present time, in chronological order, the different stages the steam engine has passed through. Taken from a treatise on "Smokeless Heat" issued by the General Engineering Co. of Toronto. 1400 w. Can Elec News—April, 1898. No. 19507.

Steam Jackets.

The Efficiency of Steam Jackets. An editorial claiming that jacketing is not worth its expense. 700 w. Eng Rec—April 16, 1898. No. 19621.

Wave Motor.

Successful Tests of the Wright Wave Motor. Illustrates and describes this motor and its working, giving results of tests. 1000 w. Elec Eng, N. Y.—April 7, 1898. No. 19429.

POWER AND TRANSMISSION.

Cables.

Improvements in the Application of Cables for Power Transmission and Hoisting. (Neueres auf dem Gebiete der Herstellung und Anwendung von Seilen für Kraftübertragungen und Hebezeuge.) Dr. K. Keller. Mainly devoted to the most efficient forms of grooves for sheaves,

and methods of twisting cables. 4000 w. Zeitschr d Ver Deutscher Ing—April 2, 1898. No. 19828 D.

Ice Handling.

The Use of an Overhead Cableway for Operating the Glacier of Casset. (Emploi des Câbles Aériens pour l'Exploitation du Glacier du Casset.) A. Dumas. Describes the method and mechanism used for the purpose of quarrying and conveying glacier ice to Paris for domestic use. 2000 w. 1 plate. Le Génie Civil—March 26, 1898. No. 19803 D.

Power Plant.

A Water Power Plant of the Jordan River, Utah. W. P. Hardesty. Brief description of an important plant in process of construction, 22 miles south of Salt Lake City. 500 w. Eng News—April 28, 1898. No. 19795.

The Dolgeville (N. Y.) Water-Power Electric Light and Power Plant. E. A. Grissinger. Deals with the organization and the technical details relating to the installation. Ill. 3400 w. Am Elect'n—April, 1898. No. 19447.

The Economical Arrangement of Hydraulic Power Plants. Walter Ferris. An outline of the points of economy, and waste in the design of hydraulic machinery. Ill. 2200 w. Am Mach—April 21, 1898. No. 19690.

See Electrical Engineering, Power.

Pulley.

The All-Wrought Steel Pulley. Report of the Franklin Inst., through its committee on Science and Arts, on the invention of Thomas Corcaden, of Philadelphia. Ill. 700 w. Jour Fr Inst—April, 1898. No. 19441 D.

SHOP AND FOUNDRY.

Bell Founding.

English Bell Founding. Brief interesting review of the bell-founders' art in England. 600 w. Arch, Lond—April 15, 1898. No. 19768 A.

Boring Mill.

A Machine Tool of the Last Century. W. S. Durfee. Describes a mill for boring gun barrels, found in a work published in 1791. Ill. 1600 w. Am Mach—April 28, 1898. No. 19930.

Castings.

A Pattern for a Crane Centre. Joseph Horner. General remarks on heavy castings in crane work, with detailed description of the pattern work involved. Ill. 2500 w. Mech Wld—April 15, 1898. No. 19760 A.

Feeding Castings. R. D. Moore. The writer's experience in feeding with criticism of work examined. 1200 w. Foundry—April, 1898. No. 19609.

Notes on Iron Founding. (Aus der Giesserei.) A. Ledebur. A discussion of the influence of the method of casting on the strength of cast iron, with comparisons of German and American data. 3000 w. Stahl und Eisen—March 1, 1898. No. 19851 D.

Some Suggestions for Producing Straight Castings. J. W. Du Bois. Brief discussion of what should be done to keep a casting straight. 1100 w. Foundry—April, 1898. No. 19610.

Chimneys.

See Architecture and Building, Miscellany.

Cranes.

Electric Cranes. J. G. Statter. Abstract of paper before the Northern Society of Electrical Engineers. Discussing the best forms of motors for use on cranes, especially in view of the frequent starting and stopping. Switchless cranes are described, in which the control is effected by changing the position of the brushes. 2000 w. Elec Engr, Lond—April 8, 1898. No. 19667 A.

The Hydraulic Cranes at the Port of Dunkirk. (Grues Hydrauliques du Port de Dunkerque.) Illustrated description of travelling hydraulic cranes, with details of hoisting mechanism and plan of the hydraulic installation. Radial cranes are mounted on bridge gantries travelling on tracks along the quay walls. 1800 w. 1 plate. La Revue Technique—April 10, 1898. No. 19-816 D.

Dies.

Screw Testing and Die Making. Illustrated description of tools the writer has seen and used. 1200 w. Am Mach—April 28, 1898. No. 19931.

Dividing Wheel.

Mechanically Originating a Dividing Wheel. John Randol. Describes a method devised chiefly by Mr. Champion, of the Newton Machine Tool Works, of Philadelphia, which the writer thinks will produce almost perfectly divided index wheels. Ill. 1600 w. Am Mach—April 28, 1898. No. 19928.

Electrical Works.

Messrs. Mavor and Coulson's Electrical Engineering Works. Illustrated description of these works, in Glasgow, for the production of electrical machinery. 1800 w. Elect'n, Lond—March 25, 1898. No. 19397 A.

Engine Shop.

Sulzer Brothers—A Swiss Engine Shop. Gives a brief outline of the principles of Swiss legislation, and the conditions affecting manufacturing, with illustrated description of this fine machinery building establishment. 4000 w. Am Mach—April 7, 1898. No. 19434.

Forgings.

Fatigue of Metal in Wrought Iron and Steel Forgings. H. F. J. Porter. Part first considers some of the defects in steel forgings which have caused their failure in the past and have tended to prevent their general use, showing that they were due to faulty methods of manufacture. Ill. 4800 w. Jour Fr Inst—April, 1898. Serial. 1st part. No. 19439 D.

The Operation of Forging Presses. (Ueber den Betrieb von Schmiedepressen.) R. M. Daelen. A discussion of the power required to drive forging presses. Indicator diagrams are given showing the power developed by the engine for various conditions of the work. 1500 w. Stahl und Eisen—April 1, 1898. No. 19-856 D.

Foundry Iron.

Furnace Facts About Foundry Iron. Charles W. Friend. Read before the Pittsburg Foundrymen's Assn. Facts about foundry iron as

seen from a manufacturer's standpoint, with tests made to determine iron of suitable analysis for various kinds of work. 1200 w. Ir Trd Rev—March 31, 1898. No. 19331.

Jig Making.

An Example of Jig Making. A. H. Cleaves. Illustrated description of a good example of jig construction designed by Fred Smith, manager of the Chicago Manufacturing Optical Co. 400 w. Am Mach—April 7, 1898. No. 19435.

Melting.

Some of the Advantages of the Positive Pressure Blower Over the Fan for Melting Iron. J. A. Caldwell. From a paper read at meeting of the New England Foundrymen's Assn. The positive pressure of the blast, and its good results are set forth. 1700 w. Foundry—April, 1898. No. 19611.

Molding.

Molding Connecting Rod Brasses. C. Vickers. Suggestions, description of method, and remarks on shrinkage. Ill. 1100 w. Am Mach—April 28, 1898. No. 19926.

Patterns.

Storing and Indexing Patterns. Oscar E. Perrigo. Describes the system in use by the writer, giving many suggestions for the storing of patterns of various sizes, the materials to be used, &c. 900 w. Am Mach—April 14, 1898. No. 19584.

Rammer.

A Portable Pneumatic Rammer. George C. Mattock. Read before the Foundrymen's Assn. Illustrated description of a portable pneumatic rammer designed by Joseph C. Cramp. 2000 w. Ir Trd Rev—April 14, 1898. No. 19593.

Reboring.

Reboring a Steam Cylinder. Charles A. Hague. An accident made it necessary to rebore a cylinder, and an account of the arrangements is given by which the work was accomplished in a single day. 1000 w. Am Mach—April 28, 1898. No. 19932.

Riveting.

Riveting by Electricity. F. von Kodolitsch. Read at meeting of Inst. of Naval Archt's., London. On the superiority of the electric system in the writer's opinion, with an illustrated description of a machine. 700 w. Engr, Lond—April 1, 1898. No. 19539 A.

Shop Costs.

An Effective System of Finding and Keeping Shop Costs. Henry Roland. Showing the practical application of the collective job ticket system as it is applied in a drop forging works with details from daily experience. 3500 w. Engineering Magazine—May, 1898. No. 19-938 B.

Shop Power.

Electric Distribution of Shop Power. George Gibbs. Read before the N. Y. R.R. Club. Describes different types on the market and comments on their suitability for railway shop work, with suggestions on the manner of laying out the system. Also discussion. 11500 w. N Y R R Club—March 17, 1898. No. 19677 D.

Shop Reconstruction.

Cost of Remodeling an Old Factory. W. S. Rogers. An account of a plant before and after reconstruction, with report of cost, and other matters of interest. Ill. 2200 w. Mach, N. Y.—April, 1898. No. 19353.

Staybolts.

Recent Improvements in Making Staybolts. Shows the method of punching test holes, and the method devised and developed by James Hartness for cutting the threads accurately in a turret lathe by means of dies. Ill. 1500 w. Am Eng & R R Jour—April, 1898. No. 19339 c.

Swedish Machinery.

Swedish Wood Working Machinery. John E. Sweet. Illustrations with descriptions of a resawing machine and a wood planing machine of unusual excellence. 1000 w. Am Mach—April 14, 1898. No. 19583.

Test Bars.

Comparative Value of Test Bars. Thomas D. West. A criticism of statements in paper of Herbert E. Field, published in the Feb. number of this paper. 2000 w. Mach, N. Y.—April, 1898. No. 19354.

Testing Tools.

Testing Machine Tools with the Micrometer Caliper. Theodore H. Miller. Presents a few of the many ways that the micrometer caliper can be applied for the purpose of making tests of the accuracy of machine tools. Ill. 1200 w. Am Mach—April 21, 1898. No. 19688.

Tool Works.

The Works of the American Tool Works Company. Illustrated description of these works, the departments, methods, packing, show cabinets, and processes. 3000 w. Ir Age—April 21, 1898. No. 19684.

MISCELLANY.**Automobiles.**

Motor-Car Machinery. T. Clarkson. Excerpt of paper read before the Automobile Club, London. Discusses the propelling machinery. 1100 w. Automotor Jour—April, 1898. No. 19902 A.

The Motor Carriage. Illustrated description of motor carriages of the past and present, with an account of the work of W. J. Still, and of a service to be opened between the City of Toronto and Richmond Hill. 3000 w. Can Eng—April, 1898. No. 19573.

Columns.

See Architecture and Building, Miscellany.

Education.

An Engineering Education. A discussion of what lines should be laid down as a guide for training an engineer. 4000 w. Jour W Soc of Engs—Feb., 1898. No. 19527 D.

Fly Wheels.

Fly Wheel Explosions. (Ueber Schwungrad-explosionen.) J. Goebel. An investigation into the stresses in the arms and runs of fly-wheels due both to rotation and to methods of construction, and a mathematical discussion of

the action of the forces causing explosions. 5000 w. Zeitschr d Ver Deutscher Ing—March 26, 1898. No. 19827 D.

Grain Tanks.

Lateral and Vertical Stresses in Grain Tanks. Max Toltz. Mathematical study, with report of experiments made by Mr. Prante, of Hamburg, Germany. 1000 w. Eng News—April 7, 1898. No. 19462.

Hydraulic Ram.

Tests of a Rife Hydraulic Ram. I. Efficiency and Capacity Test and Comparison of the Effect of "Static" and "Sliding" Head in Driving the Ram. Theo. W. Johnson and Arthur J. Wood. II. Efficiency Test under High Driving Heads and the Determination of the Lowest Ratio between the Driving and Pumping Heads. A. Beutler, Jr., P. J. Brune and Thomas J. Main. Illustrated detailed description of tests made. 5000 w. Stevens Ind—April, 1898. No. 19714 D.

Mail Vans.

The Performances of the Post Office Motor Mail Vans. Reviews the trials that have been made with automobiles for Post Office use and the degree of success attained and makes a few remarks concerning their adoption. 900 w. Automotor Jour—April 16, 1898. No. 19901 A.

Needles.

The Manufacture of Needles. Illustrated description of the work as carried on at the most important factory in the world—that of H. Milward and Sons, Ltd., in Redditch, England. 3800 w. Engr, Lond—April 1, 1898. No. 19537 A.

Nozzles.

Investigations into the Discharge of Air from Conical Diverging Nozzles. (Versuche über das Auströmen von Luft durch Konisch Divergente Rohre.) A. Fliegner. A general examination of the theory, with diagrams based upon experimental researches, with especial reference to the nozzles of the de Laval steam turbine. Three articles. 8000 w. Schweizerische Bauzeitung—March 5, 12, 1898. No. 19834 each B.

Pumps.

Auxiliary Suction Pumps. Describes a centrifugal pump driven by Pelton wheel used to lift water when the suction of main pumps has increased beyond practicable limits. 500 w. Eng Rec—April 2, 1898. No. 19408.

Recorder.

A Portable Recorder for Tests of Metals. Gustavus Charles Henning. Illustrated description of instrument designed by the writer, with report of tests. 3000 w. Stevens Ind—Jan., 1898. No. 19401 D.

Rubber Goods.

Mechanical Rubber Goods. C. Wadsworth, Jr. Illustrated description of plant and some of the products of the Manhattan Rubber Mfg. Co. whose factory is located at Passaic, N. J. 1800 w. Engr, N. Y.—April 15, 1898. No. 19614.

Smoke.

Practical Smoke Prevention. W. Nicholson. Suggestions from a smoke inspector of large experience. 1800 w. San Rec—April 15, 1898. Serial. 1st part. No. 19764 A.

Testing Bureau.

Report of the Work of the Royal Technical Testing Bureau for the year 1896-1897. (Bericht über die Thätigkeit der Königlichen Technischen Versuchsanstalten in Etatsjahre 1896-1897.) The official report of this important Government bureau, with detailed classification of the number and character of tests. 7500 w. Mitt aus den Kgl Tech Versuchsanstalt—Part 6, 1897. No. 19864 F.

Tile Works.

The New Tile Factory at Eichicht, Bohemia. (Nouvelle Tuilerie Mécanique d'Eichicht.) A general description showing the arrangement

and operation of machinery for the production of tiles with a minimum of manual labor. 1000 w. Le Génie Civil—April 2, 1898. No. 19810 D.

Tires.

The Influence of Width of Tire on Draft of Wagons. Gives the results of a series of experiments at the University of the State of Missouri, to determine the influence of the width of tire upon the draft of wagons. 1200 w. Eng News—March 31, 1898. No. 19321.

Wheel.

A New Form of Wheel for Vehicles. (Une Nouvelle Roue de Véhicule.) D. Bellet. The built-up metallic hub receives the wooden spokes upon rounded bearings in such a manner as to distribute the pressure uniformly; an improved method of lubrication is provided. 1200 w. La Revue Technique—April 10, 1898. No. 19818 D.

MILITARY ENGINEERING.**Armament.**

The Armament of Battle Ships. (Die Bewaffnung von Kriegsschiffen.) Von Neudeck. The first of an important series of articles on the artillery and armament of modern battle-ships, including guns, carriages, turrets, and mechanism of manipulation. 4500 w. Zeitschr d ver Deutscher Ing—April 2, 1898. No. 19830 D.

Arsenals.

Busy Times at Arsenals. The rush of preparing materials for war is described, with illustrations of the U. S. Arsenal at Watervliet, N. Y. 1000 w. Harper's Wk—April 9, 1898. No. 19456.

Battleships.

Defenders of Our Seacoast. Illustrates and describes many vessels of the United States navy, and the launching of the "Kentucky" and "Kearsarge." 6000 w. Engr, N. Y.—April 1, 1898. No. 19344.

Three Great Battle-Ships. Robert G. Skerrett. Brief description with illustration of the sister ships Illinois, Alabama, and Wisconsin. 700 w. Harper's Wk—April 16, 1898. No. 19579.

Breech Mechanism.

The Dashiell Breech Mechanism. An illustrated description of this mechanism as applied to a 4-inch breech-loading rifle. 900 w. Sci Am—April 30, 1898. No. 19786.

British Navy.

The Latest Reconstruction of the Navy. W. H. White. Considers the magnitude of the work that has been done, and some of its salient features. 6500 w. Nineteenth Cent—April, 1898—No. 1966 D.

British Ships.

British Ships in Foreign Navies. Archibald S. Hurd. Information concerning the warships being built by the British Government, for other Powers, with details showing the number and

character of those that have been designed, built, armed and fitted out, and remarks on the strange policy of arming the world against themselves and lending officers to train foreigners in the use of these weapons. 2300 w. Nineteenth Cent—April, 1898. No. 19607 D.

Compressed Air.

High Range Compressed Air for War Ships. Frank Richards. Explains a modification of the compressed air system, which is an improvement on the present practice. 1000 w. Am Mach—March 31, 1898. No. 19312.

Cruisers.

Purchase of Brazilian Cruisers Amazonas and Abrouill by the United States. Description of these new vessels, with data regarding their armament, and comparison with U. S. S. Cincinnati. Also descriptions of other vessels, the subject of negotiations, auxiliary ships, U. S. shipbuilding, new dock facilities, etc. Ill. 4500 w. Marine Engng—April, 1898. No. 19509 C.

Recent Trials of the Cruiser "Diadem." Sir John Durston. Read before the Inst. of Naval Arch'ts, London. An account of the contract and experimental trials with tables of mean results. Ill. 3300 w. Engng—April 8, 1898. No. 19646 A.

The New Armored Cruisers. Describes the new vessels recently ordered by England. 1200 w. Engng—March 25, 1898. No. 19384 A.

The New Second Class Cruiser "Hermes." Compares the vessel with some earlier second-class cruisers, showing the progress, and describes the important features. 1500 w. Engng—April 15, 1898. No. 19745 A.

The Powerful and Her Critics. Editorial on the unjust criticisms of this vessel, claiming that they are not justified by facts. 2000 w. Engr, Lond—March 25, 1898. No. 19390 A.

Destroyers.

The Development of the Torpedo Boat Destroyer. John Platt. A very complete and fully illustrated account of the latest develop-

ments in the construction of the torpedo boat destroyer, as distinguished from the smaller and weaker torpedo boats. 3000 w. *Engineering Magazine*—May, 1898. No. 19933 B.

Electric Equipment.

The Electric Equipment of the Cruiser "Chitose." G. W. Dickie. The equipment embraces not only a complete system of lighting, but also power hoists for the ammunition of both the main and secondary batteries, search lights, fans for ventilation, etc. Ill. 1800 w. *Elec Wld*—April 9, 1898. No. 19452.

The Present Uses and Future Prospects of Electricity on Board Ship. E. George Tidd. Read before the Glasgow Students' Assn. of the Inst. of Civ. Eng. Part first discusses position of the plant, type of plant, types of engines, etc. 2000 w. *Elec Eng, Lond*—April 8, 1898. Serial. 1st part. No. 19666 A.

Electricity on Merchant Vessels. (Die Electricität au Bord von Handelsdampfern.) C. Arldt. A general discussion of the use of electricity on merchant vessels for lighting, power, and transmission of signals. Two articles. 5000 w. *Der Electro-Techniker*—March 15, 31, 1898. No. 19879 each B.

Applications of Electricity on a Modern Warship. George H. Shepard. Discusses the wastefulness of auxiliary machinery, and the possible substitution of a central electric power plant, and shows that at the present time conditions of weight, bulk, and cost render such a system impracticable. 3500 w. *Engineering Magazine*—May, 1898. No. 19941 B.

Electricity.

Electricity in Modern Warfare. Editorial on the part played by the electrical engineers and manufacturers in the preparations for war. 700 w. *Elec Rev, N. Y.*—April 6, 1898. No. 19427.

Gun and Armor.

A Victory for the Gun over the Armor. (Une Victoire du Canon sur la Cuirasse.) A review of the American tests of Harveyized steel armor, with especial reference to the piercing of a 10 in. plate by a Johnson projectile. 2500 w. *La Revue Technique*—March 25, 1898. No. 19814 D.

MINING AND METALLURGY.

COAL AND COKE.

Alabama Coal.

Alabama Coal in By-product Ovens. William B. Phillips. An account of the testing of 54,000 lbs. of this coal, with the view of ascertaining to what extent it would lend itself to the recovery of by-products and the production of coke suitable for use in the blast furnace. 1400 w. *Am Mfr & Ir Wld*—April 1, 1898. No. 19406.

Anthracite.

A Successful Experiment in Anthracite Mining. William Tate. A method of obtaining 90 per cent. of the coal in pitching veins. Report of a visit to the Richards mine of the

Mortar Batteries.

The Sandy Hook Mortar Batteries. Illustrated description of the strongest fortifications on the American continent, for the defence of New York harbor. 1500 w. *Sci Am*—April 16, 1898. No. 19590.

Navies Compared.

The Navies of the United States and Spain—A Comparison. Illustrations of the Spanish and American war-ships, with remarks on their strength and importance. 2200 w. *Sci Am*—April 2, 1898. No. 19326.

Spanish Navy.

Spain's Naval Strength. A. K. Fiske. Information compiled mainly from a "List of the Battle-ships, Cruisers and Torpedo-boats of the Spanish Navy" prepared in the Military Information Division of the Adjutant-General's Office at Washington. Ill. 2200 w. *Harper's Wk*—April 16, 1898. No. 19578.

Squadrons.

Analysis of Squadrons of Spain and United States. Diagrams denoting the existing conditions of the two groups of battleships, armored cruisers and protected vessels, with remarks. Ill. 1000 w. *Engr, Lond*—April 15, 1898. No. 19751 A.

Submarine Boats.

Submarine Torpedo-Boats: Their Influence on Torpedo Boat Architecture and Value in Warfare. William H. Jaques. Read at meeting of the Inst. of Naval Arch'ts. General remarks on needed improvements, with descriptions of the "Plunger" and the "Holland." Ill. 3000 w. *Ind & Ir*—April 7, 1898. No. 19658 A.

Successful Trials of the Holland Submarine Boat. Illustrated description of this interesting vessel, with report of tests, and editorial. 2300 w. *Sci Am*—April 9, 1898. No. 19453.

Torpedo.

A New Automobile Torpedo. (Nouvelle Torpille Automobile.) H. Noalhat. A detailed mechanical description of the Howell torpedo, as made by the French Hotchkiss company. 3000 w. *Le Génie Civil*—March 26, 1898. No. 19805 D.

Union Coal Co., near Mount Carmel, Pa., and an account of the experiences from which the method originated. Ill. 2000 w. *Mines & Min*—April, 1898. No. 19518 C.

China.

The Coal and Iron Deposits of Eastern China. Audrel Kurita. These deposits, which have been examined by the writer, are of great importance and the exclusive right to work them has been granted to an English syndicate. The coal field is the largest known in the world. 1000 w. *Eng & Min Jour*—April 23, 1898. No. 19711.

Coal.

Coal Is King. I. The Advantage of Eng-

land and the United States in the World's Commerce. Edward Atkinson. II. The Supply of Anthracite Coal in Pennsylvania. Edward W. Parker. The advantages due to the predominance of coal, iron and steel. 1800 w. Century Mag—April, 1898. No. 19335 D.

Coal Analysis.

The Analysis of Coal. Durand Woodman. Considers the methods employed, showing that the choice depends on the purpose for which the coal is to be used. 2000 w. Stevens Ind—Jan., 1898. Serial. 1st part. No. 19400 D.

Colliery Village.

A Pennsylvania Colliery Village. I. A Polyglot Community, by Henry Edward Rood II. An Artist's Impressions of the Colliery Region. Jay Hambridge. Descriptive. Ill. 9500 w. Century Mag—April, 1898. No. 19334 D.

Gobbin Quarry.

Gobbin Quarry and Railway at the Saint-Etienne Collieries. M. Perrin. From a communication to the Société de l'Industrie Minière. Describes the arrangements made to provide a supply of gob material in all weathers, and to deliver it to all the points needed. Ill. 3000 w. Col Guard—April 7, 1898. No. 19651 A.

Haulage.

Underground Haulage. Ernest H. Thomas. From the Proceedings of the South Wales Inst. of Eng. A paper for which a prize was awarded in competition for the Lewis prizes. The subject is confined to haulage in coal mines of medium inclination. Ill. 5000 w. Col Guard—March 25, 1898. Serial. 1st part. No. 19382 A.

India.

Warora Colliery. Report of this colliery for the past year; the output, accidents, &c. 1000 w. Ind Engng—March 26, 1898. No. 19905 D.

Peat.

The Distillation of Peat in a closed Retort. (La Tourbe et sa Distillation en Vas Clos.) Fr. Miron. An investigation of the composition of the various kinds of turf fuel found in France, and the products resulting from destructive distillation. 1200 w. La Revue Technique—April 10, 1898. No. 19817 D.

Pneumatophor.

The Pneumatophor and Its Value for Saving Life After Colliery Explosions. Richard Cramer. Read before a recent meeting at Sheffield, Eng. Presents the advantages of this apparatus, describes it, and its manipulation. 1500 w. Ir & Coal Trds Rev—April 8, 1898. No. 19657 A.

Washing.

Washing Alabama Coal. A description of some of the results obtained by washing coal for coke making. The advantages gained are indicated and also the kinds of coal with which the different appliances give the most favorable results. 2300 w. Mines & Min—April, 1898. No. 19516 C.

COPPER.

Analysis.

Improved Methods of Analysis. Titus Ulke. Gives methods for the determination of arsenic and antimony in electrolytic copper, of copper in slimes, and of copper and nickel in ores and furnace products. 1300 w. Eng & Min Jour—April 9, 1898. No. 19478.

Copper Extraction.

The Extraction of Copper from Residues of Pyrites Burners. R. Helmhacker. Describes the Hoepfner method, this being the most used process, and gives particulars of the plant of the Vitkovic Copper Extracting and Electrolytic Works in Austria. 1400 w. Min & Sci Pr—April 16, 1898. No. 19708.

Copper Wire.

The Biography of a Piece of Copper Wire. C. T. Gage. An outline of the various processes through which the bare and insulated copper wire passes from its crude material to some of the forms in which it becomes useful. 2500 w. Elec Wld—April 2, 1898. No. 19333.

GOLD AND SILVER.

British Columbia.

Gold-Bearing Reefs and Placers of Northern British Columbia. William Hamilton Merritt. Notes on the general character of the placers and quartz reefs, and the general character of the ores. Ill. 3800 w. Can Min Rev—March, 1898. No. 19372 C.

Notes on Mining on the Coast of B. C. and the Adjacent Islands. G. F. Moncton. Read at meeting of the Fed. Can. Min. Inst. Information relating to this district. 1500 w. Can Min Rev—March, 1898. No. 19370 C.

Gold Fields.

Notes on the Michipicoton Gold Field. A. W. Willmott. Read at meeting of the Fed. Can. Min. Inst. Facts gathered from a brief geological examination of this district. 700 w. Can Min Rev—March, 1898. No. 19371 C.

The Golden Heart of the Sierra Madre. H. D. Slater. Illustrated description of the new gold fields of the Mexican Sierras, with some account of the country and the way to reach the mines. 2000 w. Am Rev of Revs—April, 1898. No. 19350 C.

The Minerals Which Accompany Gold, and Their Bearing upon the Richness of Ore Deposits. T. A. Rickard. Abstract of a paper read before the Inst. of Min. and Met., London. Discusses this question of indicative minerals and how far they determine the value of the deposit, giving examples from the writer's experience. 4000 w. Eng & Min Jour—April 23, 1898. No. 19712.

Kalgoorlie.

Kalgoorlie, Western Australia, and its Surroundings. George J. Bancroft. Location, manner of reaching and climatic conditions of Kalgoorlie, with information of the deposits and ores. Ill. 3300 w. Trans Am Inst of Min Eng—Feb., 1898. No. 19523 D.

Kalgoorlie, Western Australia. T. A. Rickard. A general account of this region and the writer's impressions. 1700 w. Eng & Min Jour—April 16, 1898. No. 19632.

Klondike.

The New Arctic El Dorado. Henry Wysham Lanier. An account of the gold-rush to this region, and of the routes, country, prospects, etc. Ill. 3000 w. Chau—May, 1898. No. 19913 C.

Milling.

Some Modern Forms of Milling Machinery. Frederick T. Snyder. Describes machinery designed to handle the gold ores of the Lake of the Woods, many of which are of low grade, but contain streaks of high value. The principal features were improvements in the detail of existing methods. 2500 w. Can Eng—April, 1898. No. 19570.

Mixed Sulphides.

The Treatment of Complex Lead, Zinc, Silver, Sulphide Ores. O. J. Steinhart. A brief account of past work, with special reference to its most recent developments. 3000 w. Ind & Ir—March 24, 1898. Serial. 1st part. No. 19393 A.

Oregon Mine.

The Columbia Placer, Oregon. James W. Abbott. Describes the manner of working. 2000 w. Eng & Min Jour—April 9, 1898. No. 19479.

Placer Mining.

A New Method of Placer Mining for Gold. F. B. Knight. A device for excavating and handling large quantities of material at low cost, and means by which a gold-saving flume can be used and the tailings disposed of when the surface has but a moderate degree of fall. Ill. 2900 w. Mines & Min—April, 1898. No. 19514 C.

Prospecting.

Prospecting Experiences. Arthur Lakes. General thoughts upon prospecting, with descriptions of the peculiarities of several promising but undeveloped economic deposits of minerals which are valuable though not so commonly sought after. Ill. 4000 w. Mines & Min—April, 1898. No. 19517 C.

Roasting.

Roasting Gold Ores. H. Van F. Furman. Discussing the chemistry of the process and the ores to which it should be applied, describing the different methods. Ill. 2200 w. Mines & Min—April, 1898. Serial. 1st part. No. 19519 C.

Russia.

The Kotchkar Gold-Mines, Ural Mountains, Russia. H. B. C. Nitze, and C. W. Purington. Deals especially with the deposit known as the Ouspensky mine. 2800 w. Trans Am Inst of Min Engs—Feb., 1898. No. 19528 D.

Slimes.

The Economic Treatment of Slimes. Charles Butters. Valedictory address of the president of the Chem & Met. Soc. of S. Africa. States the general features of the slimes problem, and the work of the writer in this field. Also discussion. 9000 w. Jour of Chem & Met Soc of S Africa—Feb., 1898. No. 19619 E.

Tailings.

The Tailings Plant of the Montana Mining Company, Limited. C. W. Merrill. Illustrated description of the plant, with method of operating. 800 w. Eng & Min Jour—April 16, 1898. No. 19630.

Witwatersrand.

Mining the Gold Ores of the Witwatersrand. H. H. Webb and Pope Yeatman. Especially devoted to the mechanical details of the equipment of the South African mines, with descriptions of buildings, machinery and mining appliances. Many illustrations. 3500 w. Engineering Magazine—May, 1898. No. 19940 B.

IRON AND STEEL.**American Iron.**

Great Britain's Need of American Iron. From the *London Statist*. Gives the comparative outputs of the United Kingdom, United States and Germany for each of the last seven years, and discusses the changed conditions of the iron market. 700 w. Ir Trd Rev—March 31, 1898. No. 19330.

American Practice.

Notes on American Iron and Steel Practice. Archibald P. Head. Read before the South Staffordshire Inst. of Iron & Steel Works' Managers. Notes taken during eight visits to the United States in the last eight years. Ill. 3500 w. Engng—March 25, 1898. Serial. 1st part. No. 19387 A.

Bessemer.

Sir Henry Bessemer and His Work. Reviews his career. 2000 w. Jour of Gas Lgt—March 22, 1898. No. 19322 A.

Brown Ore.

The Brown Ore Deposits Near Leeds, Alabama. William B. Phillips. Report from personal observations of the writer, who holds that the district will become a notable producer. Ill. 2000 w. Eng & Min Jour—April 23, 1898. No. 19709.

Cast Steel.

The Progress of Open-Hearth Cast Steel in Machine Construction. A. W. Discusses the improvement in methods and the investigations needed to remove the uncertainty as to interior integrity, and shows the excellent character of the open hearth cast steel. Ill. 1600 w. Ir Age—March 31, 1898. No. 19328.

Concentration.

The Magnetic Concentration of the Folkmar Red Iron Ore. (Magnetische Concentration der Folkmarer Rotheisensteine) Stefan Farbaky. A discussion of the possibility of concentrating this large body of ore by the Wetherill process, with estimate of cost, &c. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 26, 1898. No. 19875 B.

China.

The Iron Ore Beds in the Tayeh District, Hupeh Province, China. G. Leinung. Abstract translation from *Stahl und Eisen*. Report concerning the red iron ore and magnetic iron deposit, and the hematite ore deposits. 2000

w. Ir & Coal Trds Rev—April 15, 1898. No. 16756 A.

The Iron Ore Deposits of the Tayeh District, China. G. Leinung. Condensed translation. Concerning the importance of the district and the principal ore occurrences. 1200 w. Am Mfr & Ir Wld—April 1, 1898. No. 19404.

The Iron Ore Deposits in the Tayeh District, Province of Hupeh, China. (Eisenerzvorkommen im Tayeh-Bezirk, Prov. Hupeh, China.) G. Leinung. A general review of the geological and mineralogical conditions of this important deposit of iron ore, and an account of the present workings. 5000 w. Stahl und Eisen—March 1, 1898. No. 19852 D.

Cuba Iron.

Bessemer Hematite from the Island of Cuba. Details of the iron-ore mines of Cuba, with illustrations, and the low cost of production which makes it possible to ship it to British and European markets. 700 w. Ir & Coal Trds Rev—April 8, 1898. No. 19655 A.

Cupola Design.

Some Variations in Cupola Design. Part first considers cupolas attempting to secure economy through the arrangement or shape of their tuyeres. Ill. 2000 w. Ir & Coal Trds Rev—April 15, 1898. Serial. 1st part. No. 19755 A.

Explosives.

On the Various Systems of High Explosives and the Conditions of their Economical Application to the Different Methods of Coal Working in British Collieries. F. J. Rowan. Special prize essay of Ir. & Coal Trds. Rev. Part first discusses the conditions of safety in explosives and explosives due entirely to combustion. 2000 w. Ir & Coal Trds Rev—April 8, 1898. Serial. 1st part. No. 19654 A.

Furnace.

Electrometallurgy in the Iron Industry. (Elektrometallurgisches für die Eisenindustrie.) Dr. W. Borchers. A paper before the Düsseldorf Convention of the *Verein Deutscher Eisenhüttenleute*, showing the applicability of the electric furnace to the iron industry, with numerous illustrations of special constructions. 4000 w. Stahl und Eisen—April 1, 1898. No. 19855 D.

Electro-Metallurgical Memoranda of the Iron Industry. Translation and comment by Richard Moldenke. Discusses electrical heating and the electric furnace and their application to the demands of industrial requirements. 2500 w. Ir Trd Rev—April 21, 1898. No. 19707.

Furnace Gas.

See Mechanical Engineering, Power and Transmission.

Iron Making.

New Economies in Iron Making. Herman L. Hartenstein. Describes the method of producing carbolite and its value as an illuminant, and for other uses. 2800 w. Am Mfr & Ir Wld—April 22, 1898. No. 19736.

Iron Ore.

The Lake Superior Iron Ore Region. Horace V. Winchell. Gives the facts as to the discov-

ery and early history, with description of the mines and account of the present methods of exploiting them. Ill. 20000 w. Trans. of the Federated Inst. of Min. Eng. (England)—June 3, 1897. No. 19307 H.

Nickel Steel.

Researches on Nickel Steel. (Recherches sur les Aciers au Nickel.) C. E. Guillaume. A full account of the important investigations of Mr. Guillaume into the magnetic, thermal and physical properties of alloys of steel and nickel with details of the apparatus, and many tables and diagrams. An important paper. 12000 w. Bulletin de la Société d'Encour—March, 1898. No. 19825 G.

Norway Ores.

The Silicious Iron Ores of Northern Norway. H. T. Newbigin. Describes iron-ore deposits lying between 66° and 68° North. 1200 w. Ir & Coal Trds Rev—April 8, 1898. No. 19656 A.

Ore Transportation.

The Bessemer Road and Its Conneaut Terminals. Presents some features of the Pittsburgh, Bessemer & Lake Erie route from Conneaut to Pittsburgh, the harbor arrangements, and dock improvements and the importance of the road in the handling and transportation of ore. Ill. 1200 w. Ir Trd Rev—March 31, 1898. No. 19329.

Pig Iron.

Commercial Progress as Influenced by the Development of the Pig Iron Industry. John Birkinbine. Read before the Federated Canadian Mining Inst. Discusses the production of pig iron, and the reliance of the more advanced stages of manufacture upon the crude metal, as illustrated by the record made in the United States. 3000 w. Can Min Rev—March, 1898. No. 19369 C.

Need of Greater Uniformity in Pig Iron Analyses. Thomas D. West. Read by title before the Pittsburgh Foundrymen's Assn. Considers the value of chemical analyses, and factors that affect the results, giving tables. 2000 w. Am Mfr & Ir Wld—April 15, 1898. No. 19635.

The Cost and the Conditions of Producing Iron and Steel in Different Countries. Part first deals with the manufacture of pig iron in Great Britain. It is proposed to show in this series of articles the true economic circumstances in which Great Britain stands. 1400 w. Ir & Coal Trds Rev—April 1, 1898. Serial. 1st part. No. 19541 A.

Will There Be a Pig Iron Famine? C. Schoenhof. Facts bearing on this subject are presented, pointing to an affirmative answer for America. 2200 w. Ir Trd Rev—April 21, 1898. No. 19706.

Semi-Steel.

What Is Semi-Steel? Alex. E. Outerbridge, Jr. Asserting that there is no such metal, and that the material so called is not a new discovery. 1600 w. R R Gaz—April 15, 1898. No. 19600.

Steel.

Acid vs. Basic Open Hearth Steel. C. E. Stafford. A communication on the relative value for structural purposes of acid and of basic open

hearth steel. 1400 w. Ir Age—April 21, 1898. No. 19685.

Steel-Plate Tests.

Tests of Basic Open-Hearth Steel Plates. T. L. Condon. Presents 46 tests, representing 19 different melts of basic open-hearth steel. 900 w. Eng News—March 31, 1898. No. 19315.

Steel Work.

Constructional Steel Work. T. C. Cunningham. Read at meeting of the Arch. Assn., London. Part first considers columns and stanchions and their fireproofing. Ill. 2500 w. Arch, Lond—April 1, 1898. Serial. 1st part. No. 19545 A.

Steel Works.

The South Works of the Illinois Steel Company. Victor Windett. A full and clear illustrated description of these works, with discussion. 8500 w. Jour W Soc of Eng—Feb., 1898. No. 19526 D.

Swedish Iron.

The Swedish Iron, Steel, Metal, and Coal Industries in 1896. Report of these industries showing the output to be the highest on record. 1600 w. Engr, Lond—April 8, 1898. No. 19647 A.

MINING.

Colombia.

Mining Districts of Colombia. Henry G. Granger and Edward B. Treville. An interesting description of the country, its mines, and methods of working. 19000 w. Trans Am Inst of Min Eng—Feb., 1898. No. 19521 D.

Deep Mines.

Deepest Mine in the World. From the *Minneapolis Journal*. Interesting particulars of the Red Jacket Shaft of the Calumet & Hecla mine. It is 4900 ft. in depth, cost over two and a half million dollars, and has required nine years of incessant labor. 900 w. W Min Wld—April 9, 1898. No. 19567.

Demurrage.

Demurrage in Relation to the Shipment of Coal and Coke. States briefly the leading principles on demurrage applicable to the subject of this article, and mentions cases that have come before the British courts, and the decisions. 3600 w. Col Guard—April 7, 1898. Serial. 1st part. No. 19652 A.

Electric Plant.

Danger from Electrical Appliances in Coal Mines. Report of the tests made in the testing gallery of the Consolidation Colliery, near Gelsenkirchen, on the dangers from the use of electrical apparatus in coal mines. Not unfavorable, but necessary to apply the ordinary precautions. 1200 w. Engng—March 25, 1898. No. 19385 A.

Polyphase Electric Light and Power Plant at the Boryslaw Mine in Galicia. (Elektrische Drehstromanlage für Kraftübertragung in Beleuchtung der Erdwachsgruben in Boryslaw, Galizien.) A. Lukaszewski. Brief description of an important mining electric plant recently installed by Ganz & Co., of Budapest. 2500 w.

1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 5, 1898. No. 19873 B.

Eustis Mine.

Notes on the Ventilation of a Deep Metal Mine as Affected by Seasonal Changes of Temperature. John E. Preston. Considers the causes of this unsatisfactory ventilation, with the means taken to better the condition, and gives a series of analyses of the underground air. Ill. 1800 w. Can Min Rev—March, 1898. No. 19373 C.

Firedamp.

Researches on the Explosion of Firedamp Mixtures by Electric Currents. H. Couriot and J. Meunier. From *Comptes Rendus*. Some facts concerning the external influences of electricity on firedamp mixtures. 800 w. Col Guard—April 1, 1898. No. 19533 A.

The Ignition of Gaseous Mixtures by the Electric Spark. (Sur l'Explosion des Melanges Grisouteux par l'Etincelle Electrique.) A paper contributed to the French Academy by MM. Couriot and Meunier discussing the conditions under which the electric spark is capable of igniting mixtures of air and firedamp in mines. 1200 w. Comptes Rendus—March 21, 1898. No. 19821 D.

Use of Electricity in Fiery Mines, Westphalia. M. Leproux, in *Annales des Mines*. The main provisions of an ordinance dealing with the distribution and supervision of ventilation, the use of explosives, and the lighting of mines, in connection with the subject named. 3600 w. Col Guard—April 1, 1898. No. 19532 A.

Haulage.

Chain Haulage System, Humboldt System. (Kettenförderung, System Humboldt.) Robert Lamprecht. An improved system for hauling mine cars on inclines by endless running chain. 1000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 5, 1898. No. 19874 B.

Mining Haulage. G. W. Westgarth. Deals with underground haulage, indicating where the greatest economy may be effected, and showing how endless haulage installations are often unsatisfactory because of a misapplication of the load. Ill. 3800 w. Col Guard—April 15, 1898. Serial. 1st part. No. 19749 A.

Hydraulic Mining.

Defining Hydraulic Mining. Extracts from a letter by T. L. Ford, of San Francisco to an inquiry as to what constituted hydraulic mining. 1700 w. Min & Sci Pr—April 23, 1898. No. 19906.

Mine Working.

Mechanical Substitutes for Explosives at the Brussels Exhibition. Victor Watteyne and Armand Halleux. From a report on the plant and methods of mine working at the Brussels International Exhibition of 1897. 1800 w. Col Guard—April 15, 1898. No. 19747 A.

Mining Districts.

System in the Location of Mining Districts. Theo. F. VanWagenen. Gives map showing that the mining localities are situated along nearly parallel belts, and conclusions that may be drawn from this fact. 1000 w. Sch of Mines Quar—Jan., 1898. No. 19917 D.

Missouri District.

Lead and Zinc Mining. E. Hedburg. A brief history of the methods used in prospecting and mining in the Joplin Missouri District, describing the manner of shaft sinking and developing and giving some figures showing cost of the plants and their operation. Ill. 2500 w. Mines & Min—April, 1898. Serial. 1st part. No. 19515 C.

Pumping Engine.

Improved Underground Pumping Engines for Mines. (Neuere Unterirdische Wasserhaltungsmaschinen für Bergwerke.) B. Gerdau. Devoted especially to recent German pumping engines for underground mine work and hydraulic power transmission, with computations of efficiency. 7500 w. 2 plates. Glückauf—March 26, 1898. No. 19871 B.

Quebec.

Mining in Quebec in 1897. J. Obalski. Notes on the state of the mining industry in this province of Canada. 1200 w. Eng & Min Jour—April 2, 1898. No. 19364.

Safety-Catch.

Automatic Safety Catch and Brake for Hoists. (Bremsend Wirkende Sicherheits Fang-und Aufsetz-Vorrichtung für Förderkörbe.) An improved and simple form of safety stop for the cages of mine hoists as used in several mines in Saxony. A table is given of the efficient manner in which the device has operated in numerous cases. 2500 w. 1 plate. Glückauf—March 19, 1898. No. 19870 B.

Safety Doors.

A Simple Form of Brake Safety Door. (Einfach Konstruierter Bremsschacht Verschluss.) A brake mechanism is connected with the door opening device so that the hoisting gear cannot be operated until the door is closed. 1000 w. 1 plate. Glückauf—March 12, 1898. No. 19869 B.

Safety Lamps.

Some Notes on the Safety Lamp Problem. H. W. Halbaum. Discusses whether the incandescent lamp should entirely supersede the older type of safety lamp; and whether the use of safety lamps should be made compulsory in all mines. 4400 w. Col. Guard—March 25, 1898. Serial. 1st part. No. 19379 A.

Shafts.

Shaft Sinking. G. E. J. McMurtrie. From the *Proceedings* of the South Wales Inst. of Eng. A paper for which a prize has been awarded in competition for the Lewis prizes. Part first considers form of shafts, explosives, drills, methods of dealing with water, winding and disposal of the débris, &c. 4400 w. Serial. 1st part. No. 19653 A.

The Application of Compressed Air for Sinking the Sterkrade Shaft at the Gütehoffnungs Works. (Die Verwendung Komprimierter Luft beim Absinken des Schachtes Sterkrade der Aktiengesellschaft Gütehoffnungshütte.) With plan and section of the shaft cylinder and airlock, and a detailed description of the work of sinking the shaft through 16 meters of quicksand. 1800 w. 1 plate. Glückauf—March 5, 1898. No. 19868 B.

Winding Engines.

Notes on Valve Gears for Winding Engines. (Einige Bemerkungen über Fördermaschinen-Steuerungen.) P. Hartmann. A comparison of the merits of poppet and slide valves for winding engines for mine use. 1800 w. Glückauf—Feb. 26, 1898. No. 19867 B.

MISCELLANY.**Bauxite.**

The Bauxite Industry. W. M. Brewer. Report of this industry in Alabama and Georgia. The shipments for 1897 were about 20,000 tons. 1000 w. Eng & Min Jour—April 2, 1898. No. 19365.

Cobalt.

Cobalt at Port Macquarie, New South Wales. J. B. Jaquet. Report on the cobalt deposits, considering them well worth further attention by the mining community. 2000 w. Aust Min Stand—Feb. 17, 1898. No. 19562 B.

Concentration.

The Concentration of Ores. Robert H. Richards. Examines the methods of concentration, the preliminary machines, the final concentrators, and general details. 3300 w. Tech Quar—March, 1898. No. 19502 F.

Corundum.

Corundum Mining in North Carolina. A. M. Stone. Some of the peculiar conditions under which this mineral is found, with brief review of the methods of mining and milling. 1000 w. Eng & Min Jour—April 23, 1898. No. 19710.

India.

Mineral Production in India. Statistics concerning salt, coal, iron, and petroleum. 1800 w. Ind & East Engr—March, 1898. No. 19679 D.

Newfoundland.

The Mineral Resources of Newfoundland. J. H. Collins. Read at the Imperial Inst., London. Considers it one of the richest islands in the world, particularly as regards copper, and perhaps iron. Reports regarding various minerals. 2300 w. Col Guard—March 25, 1898. No. 19381 A.

Petroleum.

Development of the Oil Industry in the Apsheron Peninsula. Notes and data gathered in connection with a recent visit to the Russian oil-fields, especially those situated in the Apsheron peninsula, near Baku, on the Caspian Sea. Ill. 2800 w. Engr, Lond—April 8, 1898. No. 19648 A.

Russian Petroleum Trade in 1897. Statistics giving an idea of the progress made in the past year, showing that it was an active one, but that the financial results were not as satisfactory as in 1896. 4000 w. Cons Repts—April 6, 1898. No. 19442 D.

I. Some Facts Regarding Japanese Petroleum. From the *Kobé Chronicle*. II. Petroleum in China. The first article is a statement of the location and output of the oil wells in Japan. The second is the importance of having active agents to protect the American oil interests in China. 1700 w. Cons Repts—April 5, 1898. No. 19392 D.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene Gas on a Canadian Railway. Describes the installation on an express train of the Pontiac, Pacific Junction Railway Co., stating its advantages and disadvantages. 800 w. Can Eng—April, 1898. No. 19572.

Acetylene Gas Generator. Joseph H. Adams. A simple, safe and inexpensive apparatus that may be constructed at home is described and illustrated. 800 w. Sci Am—April 23, 1898. No. 19693.

Apparatus for the Production of Acetylene Gas. (Appareils de Production du Gaz Acétylène.) E. Hubon. The first of a series of articles describing and illustrating the various generators for producing acetylene gas from calcium carbid. Serial. Part I. 2000 w. Le Génie Civil—March 26, 1898. No. 19804 D.

Calcium Carbid in Ontario. From the annual report of A. Blue, Mineral Commissioner of Ontario. Information of progress made, and of apparatus of various types for its generation and control. 1800 w. Ir Age—April 7, 1898. No. 19437.

Carbid of Calcium and Acetylene. C. de Perrodil. The first of a series of articles constituting a complete translation from a work in French. Foot notes will be given bringing the subject matter up to date, and including special developments in the United States. Part first gives historical facts, and properties of the substance. 2700 w. Pro Age—April 15, 1898. Serial. 1st part. No. 19628.

The Efficiency of Acetylene Burners. A. Weber. Abstract translation of a paper reprinted in the *Journal für Gasbeleuchtung*. Experiments made to ascertain the quality of various burners, as all burners so far used smoke after a short period of use. 800 w. Jour of Gas Lgt—April 5, 1898. No. 19618 A.

Calcium Carbid.

A New Plant for the Manufacture of Calcium Carbid. John C. Temple. Illustrations and description of the new works of the Willson Ammonium Co., located on the James River, at Holcomb Rock, Virginia. 2500 w. Eng News—April 14, 1898. No. 19595.

Carbonic Oxid.

The Toxic Properties of Carbonic Oxid. N. Grehan. Experiments recently made upon absorption by the blood, describing apparatus and method, and giving results. 2000 w. Gas Wld—April 9, 1898. No. 19668 A.

Coal Gas.

The Manufacture of Coal Gas. J. G. Newbigging. Lecture delivered at Macclesfield, Eng. Abstract. Describes the process and the apparatus, and refers to other matters of interest. 1800 w. Gas Eng's Mag—April 11, 1898. No. 19774 A.

Cost.

The Cost of the More Generally Used Sources of Illumination. (Kosten der Gebrauchlichsten Lichtquellen.) An investigation of the relative

cost of illumination in Germany, using various forms of gas burners, acetylene, spirit incandescent lamps, petroleum, and various electric lamps. 3500 w. Gesundheits-Ingenieur—March 15, 1898. No. 19862 B.

Discussion.

The Gaslight and Coke Company. Reply of the Chartered Company's Directors to Mr. George Livesey's "impeachment," dealing with each of the allegations and charges in their order. 13000 w. Jour Gas Lgt—April 12, 1898. No. 19740 A.

Gas Works.

Modern Gas Engineering. M. S. Greenough. Gives a description of modern gas works, and indicates how they have been modified during the past few years. Also discussion. 6300 w. Jour Assn of Eng Soc—Feb., 1898. No. 19362 C.

Holophone Globes.

The Holophone Globes, for Effecting the Better Diffusion and Distribution of Artificial Light. Report of the Franklin Inst., through its committee on Science and Arts, on the invention of Messrs. Blondel and Psaroudaki, of Paris, France. Ill. 3000 w. Jour Fr Inst—April, 1898. No. 19440 D.

Inspection.

A House to-House Inspection Wanted. Norton H. Humphreys. Comments on the universal popularity of electricity for shop window lighting, with inquiry as to the cause. Suggests canvassers, or inspectors visiting from house to house to secure business and remedy defects in lighting. 1800 w. Jour Gas Lgt—March 29, 1898. No. 19480 A.

Leakage.

Leakage in Mains and Services. J. M. Rusby. Remarks on methods of locating and correcting existing leakage, and means of avoidance. 1700 w. Gas Eng's Mag—April 11, 1898. No. 19775 A.

Municipal Gas.

Some Recent Municipal Gas History. Edward W. Bemis. Discussing the lease of the Philadelphia gas-works, for thirty years, to a private company, after fifty-six years of public ownership and operation. 4500 w. Forum—March, 1898. No. 19492 D.

Municipal Lighting.

See Electrical Engineering, Lighting.

Paris.

The Gas Supply of Paris. Edward Conner. Interesting particulars connected with the Paris supply, with account of its development. 2000 w. Plumb & Dec—April 1, 1898. No. 19613 A.

Photometry.

See Electrical Engineering, Lighting.

Purification.

The Heat Developed During Purification by Means of Weldon Mud. A computation of the temperature which may supervene from the reactions which occur during the fouling and re-

vivification of Weldon Mud. 1800 w. Jour of Gas Lgt—March 22, 1898. No. 19323 A.

The Relative Activity of Bog Oxid and Weldon Mud as Purifying Materials. Discusses the intrinsic merits of bog oxid and of Weldon mud. 2000 w. Jour of Gas Lgt—April 19, 1898. No. 19907 A.

The Work of the Scrubbers and Purifiers. Stephen Carpenter. Describes the action of the scrubbers and the manner of working, with remarks on the size of lime and oxid of iron purifiers relatively to the make of gas. 1800 w. Jour Gas Lgt—April 19, 1898. No. 19909 A.

Street Mains.

Street Main and Service Pipe. J. H. Fitzgerald. Read at meeting of the Texas Gas and Electric Light Assn. at Laredo. An outline of what the writer believes necessary in laying and carrying out the actual work to be done. Discussion. 5800 w. Am Gas Lgt Jour—April 18, 1898. No. 19636.

Sulphur.

A New Method for the Determination of Sulphur in Gas. A brief description of the method and apparatus devised by Antonio Longi, of Rome, as published in the *Gazetta Chimica Italiana*, with editorial criticism. 2800 w. Jour of Gas Lgt—April 5, 1898. No. 19617 A.

Water Gas.

A New Method of Producing Water Gas. Carl Dellwik. From *Jernkontorets Annaler*. Describes the process and makes comparisons between the theoretical value and possibilities of the three kinds of gases—producer gases, water gas by the old process, and by the new. Ill. 2800 w. Ir Age—April 28, 1898. No. 19900.

Welsbach.

Incandescence in Welsbach Mantles. H. Bunte. Abstract from the *Journal für Gasbeleuchtung* and the *Journal de l'Eclairage au Gaz*. Investigations demonstrating that the highly luminous properties are due to the high temperatures which they are capable of attaining. 1500 w. Gas Engs' Mag—April 11, 1898. No. 19776 A.

The Welsbach Incandescent Electric Lamp. A. M. Gibson. Gives particulars taken from the complete specification. 1800 w. Elec Rev, Lond—April 15, 1898. No. 19770 A.

SEWERAGE.

Disposal.

Chemical Treatment of Sewage at New Rochelle, N. Y. Describes the operation of a small plant. 700 w. Eng Rec—April, 1898. No. 19726.

Sewage Disposal at Newport, Isle of Wight. Illustrates a chemical treatment plant and an inverted syphon. 700 w. Eng Rec—April 16, 1898. No. 19624.

Sewage Disposal Through the Action of Bacteria. W. M. Watson. Information gathered from leading bacteriologists, chemists and engineers, and from the writer's experience. 2300 w. Can Eng—April, 1898. No. 19568.

The Proper Disposal of Sewage. C. E. Grumsky. Read before the Convention of Health Officers in San Francisco. Discussing how sewage should be disposed of and collected.

Filtration is considered the solution. 3700 w. San—April, 1898. No. 19403 D.

Purification.

The Oxygen System of Sewage Purification. W. M. Watson. Explains the System of the Sewage Purification Co., of Dublin, Ireland. 700 w. Can Eng—April, 1898. No. 19569.

The Proper Use of Land in Connection with Sewage Purification. W. J. Dibdin. Consideration of means of attaining the best results. 1400 w. San Rec—April 1, 1898. No. 19548 A.

Sewers.

A Composite Sewer. Illustrates sewers of concrete and expanded metal used in Boston. 300 w. Eng Rec—April 2, 1898. No. 19414.

A Steel Street Sewer. Illustrates a 48- and a 66-inch rivetted steel sewer in Jersey City. 500 w. Eng Rec—April 2, 1898. No. 19413.

Damages from Imperfect Surface Drainage. Review of decision of Michigan Supreme Court awarding damages against a city for negligent construction of surface drainage system. 800 w. Eng Rec—April 16, 1898. No. 19620.

The Acheres Aqueduct, Paris. Describes syphon and masonry conduit on the main outfall sewer of Paris. Ill. 1700 w. Eng Rec—April 9, 1898. Serial. 1st part. No. 19474.

The New Intercepting Sewerage System of Chicago. Illustrates details of this work, which is described in outline, for turning sewage from Lake Michigan toward the drainage canal. 1600 w. Eng Rec—April 9, 1898. No. 19472.

The New Intercepting Sewer for Chicago. Describes this important work and gives an abstract of the specifications for the main conduits on Lawrence ave., and 39th street. Ill. 6500 w. Eng News—April 21, 1898. No. 19700.

Ventilation.

Experiments on Secondary Ventilation Pipes for House Drainage Systems. (Versuche über die Notwendigkeit der Sekundären Entlüftungsröhre bei Hausentwässerungsleitungen.) A. Unna. With full details of important experiments, using gages on the various syphon traps under different conditions, showing the effects of flushing with and without proper ventilation. Two articles. 7500 w. Gesundheits-Ingenieur—Feb. 28, March 15, 1898. No. 19861 each B.

WATER SUPPLY.

Brooklyn Water Works.

The New Pumping Engines and Boiler House at the Ridgewood Station of the Brooklyn Water Works. Illustrated description. 1700 w. Power—April, 1898. No. 19432.

Cement Pipe.

Test of Crushing Strength of Cement Pipe. Arthur S. Bent. Describes tests made to determine the amount of fill the pipes would stand when laid. 1200 w. Eng News—April 14, 1898. No. 19597.

Deep Well Pump.

The Iowa Agricultural College Deep Well and Pump, Ames, Ia. A. Marston. Gives results of test of well and pump under different

conditions. 1200 w. Eng Rec—April 2, 1898. No. 19412.

Detroit.

Water Supply of Detroit, Michigan. Report of the prosperous condition of the works, the reduction of rates, improvements made, &c. Ill. 1100 w. Fire & Water—April 23, 1898. No. 19738.

Fan Pump.

The Fan Pump. F. C. Hooper. Illustrates and describes a special instance of its use for mill water supply. 900 w. Sch of Mines Quar—Jan., 1898. No. 19918 D.

Filter Cribs.

Filter Cribs in the Allegheny River, near Pittsburg, Pa. Describes cribs built with the object of removing matter carried in suspension by the river. Ill. 1200 w. Eng News—April 28, 1898. No. 19793.

Germ.

The Vitality of Pathogenic Germs in Drinking Water. B. Meade Bolton. On the variability of the bacteria and experiments made to determine their vitality. 1300 w. San Rec—April 15, 1898. No. 19765 A.

Harrisburg, Pa.

Water Supply of Harrisburg. An account of the improvements made which have overcome the pollution of the water by culm, and by sewage, and increased the supply. 1200 w. Fire & Water—April 9, 1898. Serial. 1st part. No. 19520.

Meter Rates.

The Right to Sell Water by Meter Rates. Abstract of decision of the Superior Court of Pennsylvania establishing the legality of meter rates in case all supplies are not metered. 1000 w. Eng Rec—April 9, 1898. No. 19469.

Pumping Engine.

Test of a Triple Expansion Steam Pumping Engine at the St. Gall Waterworks. (Versuche an einer Dreistufigen Dampfpumpmaschine im Wasserwerk der Stadt St. Gallen.) A. Stodola. Full details of the test of this Sulzer engine are given, with a complete table of data and results. 3500 w. Schweizerische Bauzeitung—Feb. 19, 1898. No. 19832 B.

Purification.

The Purification of River Water Supplies. Allen Hazen. Especially devoted to a description and illustration of modern sand filters, showing details of construction, and demonstrating the success which has attended their use. 2500 w. Engineering Magazine—May, 1898. No. 19939 B.

Tank.

A Curious Historical Water Tank. Illustrated description of a cast-iron tank of 140,000 gallons capacity, built a century ago by the Manhattan Company of New York, to hold its banking franchise, which it obtained under the guise of a water company. 1000 w. Eng Rec—April, 1898. No. 19724.

Water Privileges.

The Privileges of a Water Company. Review of a decision of U. S. Circuit Court that a pri-

vate company may be exempted from municipal taxation in return for free water for public purposes. 800 w. Eng Rec—April 23, 1898. No. 19719.

Watershed.

The Bronx Watershed. Describes this district which gives an additional supply to New York. 900 w. Fire & Water—April 16, 1898. No. 19634.

Water Supplies.

The Protection of Underground Water Supplies. John C. Thresh. Read before the Soc. of Engs, England. Considers briefly some sources of underground supply known to have caused epidemics, and the natural processes of purification. 3500 w. Brit Arch—April 8, 1898. Serial. 1st part. No. 19665 A.

Cheap Water for a Small Town. Illustrates a plant with gas engines and triplex pumps at Caledonia, N. Y., which furnishes water at a very low cost per capita. 1000 w. Eng Rec—April 23, 1898. No. 19725.

Water Works.

The Wachusett Reservoir and Aqueduct. Illustrates and describes temporary dam and important features of aqueduct of the metropolitan works for Boston and vicinity. 4000 w. Eng Rec—April 9, 1898. No. 19471.

MISCELLANY.

Baths.

See Architecture and Building, Construction.

Disinfection.

A New Apparatus for Continuous and Automatic Disinfection. (Ein neuer Apparat zur Kontinuierlichen und Automatischen Desinfektion.) Dr. H. Köhler. The disinfecting liquid is kept in circulation by capillary action, and evaporated from the surface of a porous plate. The liquid used is generally coal-tar containing a high percentage of carbolic acid. 2000 w. Gesundheits-Ingenieur—Feb. 28, 1898. No. 19860 B.

Plan.

The City's Plan. J. F. Harder. Discusses to some extent the plans of cities in general, but is chiefly devoted to New York and the improvements that should be made. Ill. 6700 w. Munic Af—March, 1898. No. 19555 C.

Public Franchises.

A Successful Substitute for Municipal Ownership. Alfred F. Potts. Indicates a solution of the question how the people may own and control street railways, water, telephone and light companies without resorting to municipal ownership. Outlines the plan of organization on which the Consumers' Gas Trust Co., of Indianapolis was formed. 2800 w. Munic Engng—April, 1898. No. 19396 C.

Sculpture.

Municipal Sculpture. Karl Bitter. Suggestions for the beautifying of New York by statues, fountains, fine buildings, and other decorative works of art, with reference to work in other cities. 10000 w. Munic Af—March, 1898. No. 19557 C.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

The Prussian Railroad Commission on the Epidemic of Accidents. Data from a memorial submitted by the Minister of Railroads to the Prussian Diet, on the provisions for safety and their effectiveness. 1400 w. R R Gaz—April 15, 1898. No. 19603.

Train Accidents in the United States in March. Detailed list and classified summary for the month named. 3500 w. R R Gaz—April 29, 1898. No. 19924.

Employees.

Railway Companies and Their Employés. H. P. Robinson. Extract from an article in *Locomotive Firemen's Journal*. The importance of co-operation, and an explanation of many matters not understood by employés. 2500 w. Ry Age—April 8, 1898. No. 19560.

German Railroads.

Notes on German Railroads. J. Pearson Patinon. Some of the salient points of German railroad working, discussing passenger rolling stock, fares, stations and speed. 1800 w. R R Gaz—April 15, 1898. No. 19601.

Loading Lumber.

Loading Lumber as Lumbermen See It. Editorial published in *The Timberman* from the view of the shipper, in regard to the furnishing of box cars when required for valuable lumber, and the unjust charges when such cars are not furnished. 1300 w. Ry & Engng Rev—April 23, 1898. No. 19763.

Management.

Ethics of Railroad Management. William Taussig. An address before the Commercial Club of St. Louis, with editorial comment. Considers some of the points that might become subjects of railroad ethics. 5800 w. R R Gaz—April 15, 1898. No. 19599.

FINANCIAL.

American Railroads.

Mr. Acworth on American Railroads. Extracts from the fourth of a series of articles in the *London Times*. Considers the financial position of American railways and concludes that at least in the northeastern section they have reached a comparatively stable and prosperous position. 2000 w. R R Gaz—April 29, 1898. No. 19920.

Deserted Railway.

A Deserted Railway in New York. Concerning the Lebanon Springs railroad, extending from Chatham, N. Y., to Bennington, Vt., which has not been operated since Aug. 7, 1897. 1100 w. Ry Age—April 22, 1898. No. 19734.

Earnings.

Large Railroad Earnings. Reports the earnings of 120 railroads of the United States, for the month of March, which shows a gain of 15.3% over March, 1897. 1500 w. Bradstreet's—April 16, 1898. No. 19615.

Railroads.

The Nation's Railroads. George B. Waldron. On the development of the railroads of the United States, giving information also of the financial side. Ill. 1700 w. McClure's Mag—April, 1898. No. 19337.

Railway Finance.

Electric Railway Finance. W. R. Lawson. Part first is a historical review of the progress of electric railways, principally confined to Great Britain. 5200 w. Bankers' Mag, Lond—April, 1898. Serial. 1st part. No. 19498 B.

LEGAL MATTERS.

Claim Agents.

The Claim Agent. S. D. Webster. From a paper read before the St. Louis Ry. Club. Considers the information needed by a good claim agent and the personal qualities desirable. 2000 w. R R Gaz—April 15, 1898. No. 19605.

Employers' Liability Act.

Railway Companies and the Employers' Liability Act. Part first explains the arrangements made by the London and Northwestern railway company to meet the new conditions. 1000 w. Transport—April 1, 1898. Serial. 1st part. No. 19546 A.

Freight Rate Law.

The Supreme Court on the Nebraska Freight Rate Law. Editorial on the decision which nullified the Newberry freight-rate law, and the efforts being made to have it modified. 1600 w. R R Gaz—April 15, 1898. No. 19604.

Interstate Commerce.

The Dangerous Demands of the Interstate Commerce Commission. Milton H. Smith. Considers that the Commission's radical demands will not correct the evil which requires correction, and that all other evils are sufficiently guarded against by the Act as it stands. 6300 w. Forum—April, 1898. No. 19493 D.

Legislation.

Railroad Legislation in Massachusetts. Editorial on the railroad policy of this state, as shown in the recently passed law to help the Boston & Maine road to retain control of its leased lines, and the discussion during its passage. 1400 w. R R Gaz—April 8, 1898. No. 19468.

State Regulation.

State Regulation of Railways. Harry Perry Robinson. Discusses the effect of the decision of the United States Supreme Court in what is known as the Nebraska Maximum Rate case. 3300 w. N Am Rev—April, 1898. No. 19357 D.

MOTIVE POWER AND EQUIPMENT.

Air-Brake Hose.

Specifications for Air Brake Hose. Report of the Committee of the Central Ry. Club, with tests and standard specifications of the L. S. & M. S. Ry., the Erie Ry. and the C. B. & Q. Ry.

4200 w. Central Ry Club—March, 1898. No. 19591 D.

Balanced Valves.

The Application of Balanced Valves to Locomotives. (Die Anwendung der Entlasteten Schieber bei Locomotiven.) August Birk. Describing the various methods of relieving the pressure from locomotive slide valves, in British, French and American practice. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19849 D.

Car Lighting.

Experience with Acetylene Gas for Car Lighting. Letter from P. W. Resseman, giving information of the economy and convenience resulting from the adoption of this system of lighting on the Pontiac Pacific Junction Ry. of Canada. 600 w. Eng News—March 31, 1898. No. 19317.

Chilled Wheels.

The Chilled Cast-Iron Wheel. R. P. C. Sanderson. Considers the relative merits of cast-iron and steel tired wheels, favoring the former. 3300 w. R R Gaz—April 29, 1898. No. 19921.

Couplers.

The M. C. B. Coupler. Gustav Giroux. From a paper presented at meeting of the Western Railway Club. On the advantage accruing from the use of drop tests of couplers, with data derived from tests. 3000 w. R R Gaz—April 8, 1898. No. 19466.

Drawbar.

Improvement in Railway Drawbars. (Verbesserung der Zugvorrichtung für Eisenbahnwagen.) H. Wick. An improved spring drawbar, suggested as the standard for the German railways. 1200 w. Glaser's Annalen—March 15, 1898. No. 19838 D.

Locomotive Boiler.

Fitting Pedestal Binders and Setting Frames. Ira A. Moore. Showing how back frames may be properly lined and squared up when they have been taken down to allow boiler repairs. 2000 w. Loc Engng—April, 1898. No. 19367 C.

Locomotive Details.

Unnecessary Labor in Locomotive Details. P. M. Hammett. Extracts from paper read at meeting of the New England R R Club. Examines the principles of design with a view to securing economical results, and the conditions of shop practice. 1400 w. R R Gaz—April 8, 1898. No. 19464.

Locomotives.

Compound Consolidation Locomotives for the South Carolina & Georgia Railroad. Illustrated description of heavy two-cylinder compounds built by the Richmond Locomotive Works. 500 w. R R Gaz—April 22, 1898. No. 19703.

Consolidation Locomotive—Cleveland, Cincinnati, Chicago & St. Louis. Illustrated detailed description giving dimensions. 700 w. R R Gaz—April 15, 1898. No. 19602.

Locomotive Design. Francis J. Cole. On the determination of the proper working stress of materials. 2000 w. Am Eng & R R Jour—

April, 1898. Serial. 1st part. No. 19340 C.

Modern British Express Engines—Their Construction and Work. Charles Rous Martin. Illustrates and describes various types, giving historical information. 5500 w. R R Gaz—April 8, 1898. No. 19465.

New Class "G." Locomotives for the Wabash. Description with dimensions and illustrations of locomotives all of whose important parts are interchangeable. 1000 w. R R Gaz—April 1, 1898. No. 19346.

New High-Speed Locomotives for the Northern Railway of France. (Nouvelles Machines à Grande Vitesse de la Compagnie du Nord.) The specifications of the new four-cylinder compound express locomotives designed by M. du Bousquet for the Northern Railway of France, with plate of details and photographic elevation. 2000 w. 1 plate. La Revue Technique—March 25, 1898. No. 19813 D.

New Standard Locomotives—Grand Trunk Railway. Illustration and principal dimensions with brief description. 800 w. Am Eng & R R Jour—April, 1898. No. 19342 C.

106-Ton Twelve-Wheel Locomotive; Great Northern Railway. Illustrates and describes an enormous locomotive and its interesting features. 1200 w. Eng News—April 14, 1898. No. 19596.

Six Coupled Tank Engine for the Trans-Manchurian Railroad. Illustrated description with dimensions. 700 w. R R Gaz—April 29, 1898. No. 19922.

Southern Railway Ten-Wheelers. Illustration and general description. 800 w. Loc Engng—April, 1898. No. 19366 C.

The Performance of a Four-Cylinder Compound Locomotive. Richard A. Smart. A paper presented before the St. Louis Railway Club. A record of tests for the purpose of investigating the cylinder performance of the compound locomotive at high speeds. Ill. 1600 w. Pamphlet. St. Louis Ry Club. No. 19496 D.

The Locomotives of the Paris, Lyons and Mediterranean Railway. Information concerning types of engines constructed by this company, with leading particulars of two new locomotives and illustrations showing their details. 1700 w. Engng—April 15, 1898. No. 19746 A.

Mail Car.

Mail Car—L. S. & M. S. Railway. Illustrated description of a carefully planned mail car for the Lake Shore & Michigan Southern Railway. 500 w. Ry Mas Mech—April, 1898. No. 19561.

Motor Car.

A Composite Steam Motor Car for the Erie Railroad. Illustration, general dimensions and equipment. 400 w. Ry & Engng Rev—April 2, 1898. No. 19422.

Steam Motor Cars by the Baldwin Locomotive Works. Illustrated description of two recently completed cars, one to be used on the C. H. & D. R. R. and the other on the D. & L. N. R. R. 900 w. Am Eng & R R Jour—April, 1898. No. 19341 C.

Oil-Sprinkling Car.

Oil-Sprinkling Car—Long Island Railroad.

Engravings showing the details, with description, and a letter from C. S. Addison, General Road Master, stating the advantages. 800 w. R R Gaz—April 29, 1898. No. 19925.

Paint Oil.

Note on a Test of a New Paint Oil. William G. Raymond. Illustrates and describes the test made, giving results which were very favorable. Recommends it for car and depot painting. 1700 w. R R Gaz—April 29, 1898. No. 19923.

Roofing.

Car Roofing. Taken from discussion on this subject at a meeting of the North-West Ry. Club. The opinions of Alfred Child of the Northern Pacific, and C. D. Brooke, of the St. Paul & Duluth Ry. 900 w. R R Gaz—April 8, 1898. No. 19467.

Sleeping Car.

New Sleeping Cars for the Prussian State Railways. (Neue Schlafwagen der Preussischen Staatseisenbahn-Verwaltung.) An improved stateroom car with corridor on one side, excellent toilet, and vestibuled platforms. 1200 w. 1 plate. Glaser's Annalen—April 1, 1898. No. 19839 D.

Tank Feeder.

Pumping Water with Locomotives. Illustrated description showing the features and operation of a railway water-tank feeder; patented by John W. Skilton of Chicago. 900 w. Ry & Engng Rev—April 23, 1898. No. 19761.

Train Resistance.

The Resistance of Rolling Stock to Traction at High Speeds. (Résistance à la Traction du Matériel Roulant à Grand Vitesse.) F. Barbier. A discussion of the recent experiments made on the Northern Railway of France, with diagrams and curves, showing the relation between speed and resistance. 2000 w. Le Génie Civil—April 9, 1898. No. 19812 D.

Train Stopping.

The Engine Truck Brake as an Aid in Train Stopping. Report of committee presented at meeting Air Brake Men's Assn., at Baltimore. 1800 w. Ry Age—April 15, 1898. No. 19633.

Tubular Car.

The Church and Ettenger Tubular Car. Illustrates and describes this construction and discusses why it is not a success in the United States, while it seems in favor in Tasmania. 3000 w. R R Car Jour—April, 1898. No. 19513.

Wrecking Crane.

Steam Wrecking Crane for the Atchison, Topeka & Santa Fé. Illustrates and describes a heavy crane of 35 tons capacity designed for emergency service. 1100 w. R R Gaz—April 1, 1898. No. 19347.

NEW PROJECTS.

China.

China, and Chinese Railway Concessions. Clarence Cary. Discussing the railway possibilities in China, and the general subject of railway-extension; also other business enterprises. 6000 w. Forum—Jan., 1898. No. 19486 D.

The Proposed Railways of Shansi, China. These railways will connect Peking and the coast line with extensive deposits of coal and iron. The contour of the country and the difficulties to be met in the construction are discussed. 1200 w. Eng News—March 31, 1898. No. 19320.

Colombia.

Railway Contract in Colombia. Copy of a contract for the construction of a railroad from the port of Girardot to the Savannah of Bogotá. 800 w. Cons Repts—April 19, 1898. No. 19660 D.

Greece.

Piræus-Larissa Railway. Gives an account of the work already done, and that remaining. 800 w. Cons Repts—April 28, 1898. No. 19903 D.

New Lines.

Opening of New Lines. An account of the opening of the Great Northern's Leen Valley extension, and the Lambourn Valley railway. 2200 w. Transport—April 8, 1898. No. 19670 A.

Railway Contract.

Newfoundland Railway Contract. Synopsis of a contract between the government of Newfoundland and Robert G. Reid, of Montreal. 3000 w. Cons Repts—April 27, 1898. No. 19778 D.

Venezuela.

Railway Contracts in Venezuela. Translations of contracts made with the Government for the construction of the Perico-Crucero and the Los Teques-Cua railroads. 1800 w. Cons Repts—March 30, 1898. No. 19327 D.

PERMANENT WAY, BUILDING AND FIXTURES.

Ballast.

Tests of Gravel and Broken Stone for Use as Railway Ballast. (Untersuchungen von Kies und Steinschlag zur Beurtheilung ihres Werthes als Stopfmateriel für den Eisenbahnoberbau.) M. Rudeloff. Important researches made at the government testing bureau, with especial reference to various German gravels, but also of value for other localities. Many tables and diagrams. 1800 w. Mitt aus d Kgl Tech Versuchsanstalt—Part 6, 1897. No. 19865 G.

Boston Union Station.

New Southern Union Station at Boston. Illustrated description of a new station, the largest ever constructed, to be used by the Boston & Albany, the New England, and the New York, New Haven & Hartford systems. 1500 w. Ry & Engng Rev—April 2, 1898. No. 19423.

Frog Formulas.

A Method of Determining Railway Crossing Frog Formulas. G. B. Zahniser. Mathematical. 500 w. Eng News—April 21, 1898. No. 19696.

Interlocking.

Small Interlocking Plant at East Clinton, Ill. Illustrated detailed description. Ry & Engng Rev—April 16, 1898. No. 19678.

Paris Station.

The Orleans Station in Paris. An account of the location and plans for two new stations in

Paris, for the Orleans Railroad of France. Ill. 1300 w. RR Gaz—April 1, 1898. No. 19349.

Rails.

Converting Worn Out Rails into Posts. F. G. Lynde. Describes a process by means of which rails were split and made into fence posts, at a cost of two and a quarter annas per post. Ill. 2000 w. Ind Engng—March 5, 1898. No. 19554 D.

Railway Shops.

Concord Shops—Boston & Maine Railroad. Illustrated descriptions of the boiler plant, power house, generators, motors, and steam heating system. 4500 w. Am Eng & RR Jour—April, 1898. No. 19338 C.

Steel Ties.

Experience with Steel Ties on the Gothard Railway, Switzerland. Particulars as to the experience of this road, taken from a report showing the results obtained up to Jan., 1898, and giving the present opinions of the officers of the railway. 1000 w. Eng News—April 7, 1898. No. 19460.

Steel Cross Ties on the St. Gothard Railway. (Les Traverses d'Acier au Chemin de Fer du Saint Gothard.) A review of the experiences with steel ties from 1882 to 1898. In addition to the constructive advantages, a marked economy over wooden ties appeared. 1000 w. La Revue Technique—April 10, 1898. No. 19819 D.

The Use of Metal Ties on the Turkish Railways. (Emploi des Traverses Métalliques sur les Chemins de Fer Turcs.) A. Magnier. With illustrations showing the machines for transporting and placing sections of track, with steel sleepers. 2000 w. 1 plate. Le Génie Civil—March 19, 1898. No. 19800 D.

Switch Leads.

Simple and Accurate Rules for the Computation of Shortened Switch Leads. Wellington B.

Lee. Gives a set of arithmetical formulas which give surprisingly accurate results. 800 w. Eng News—April 21, 1898. No. 19697.

Turntable.

Designs for Standard 60-ft. Center-Bearing Locomotive Turntable. C. L. Strobel. Illustrated description of recent designs of the writer differing from the usual type in that no trailing wheels are used, and also in the manner in which the load is supported at the center. 1200 w. Eng News—March 31, 1898. No. 19319.

The Use of Electricity for Turning Locomotives and Cars. J. G. Rawn. Describes a plan devised for turning the 60-ft. turntable at Chillicothe, O., by means of an electric motor. Ill. 600 w. Am Elect'n—April, 1898. No. 19449.

Water Station.

Water Station Improvements on the Wheeling & Lake Erie Railway. Illustrated description of tanks supported on cast iron columns, and with other improvements in details. 800 w. Ry & Engng Rev—April 9, 1898. No. 19592.

TRAFFIC.

Fares.

Railroad Fares and Passenger Travel. H. G. Prout. A discussion of this important problem by an expert, showing the intricacy of the subject and the many interdependent factors of which it is composed. 3000 w. Engineering Magazine—May, 1898. No. 19934 B.

Pooling.

Railroad Pooling and Sound Public Policy. Frank J. Firth. Extracts from a paper read before the Merchants' Assn. of New York. Calls attention to the large number directly or indirectly dependent upon the successful operation of the railroads, explains pooling and the advantages made possible by its agreements. 1700 w. R R Gaz—April 22, 1898. No. 19702.

STREET AND ELECTRIC TRAMWAYS.

Accumulators.

Experiments with an Accumulator Test Car, with Shunt Motors and Improved Regulator. (Versuchsfahrten mit einem Akkumulatorenwagen mit Nebenschlussmotoren und einem Neuen Steuerapparat.) E. G. Fischinger. With elaborate power diagrams and detailed drawings of the controller system. 2500 w. Elektrotechnische Zeitschr—March 24, 1898. No. 19889 B.

Baltimore.

The System of the Baltimore and Northern Electric Railway Company. Illustrated detailed description. 2500 w. St Ry Jour—April, 1898. No. 19417 D.

Belgium.

Belgian Tramways and Light Railways. Illustrated description of the system of communication. There are twenty-nine lines be-

longing to seven companies. Ill. 2000 w. Ry Wild—April 7, 1898. No. 19638 A.

Boston Elevated.

The Boston Elevated Railroad. Information concerning the construction, equipment and operation of this proposed road. Ill. 1800 w. R R Gaz—April 22, 1898. No. 19704.

Boston Ry. Stations.

Competitive Designs for Stations on the Boston Elevated Railway. Reproductions of nine of the eleven designs recently submitted, giving the conditions of the competition. 400 w. Eng News—March 31, 1898. No. 19316.

Brake.

The Electromagnetic Brake of the Union Electric Company. (Die Elektromagnetische Bremse der Union Elektrizitäts-Gesellschaft.)

M. F. A. Kubierschky. Illustrated description of a brake used on the Dresden tramways. A disc on the axle is acted upon by stationary magnets. The current is taken from the motors. 2000 w. *Elektrotechnische Zeitschr*—April 7, 1898. No. 19891 B.

Car Building.

Building Cars for Export. Describes an improved system for the construction of "knock down" cars, or of cars that can be taken apart and snugly packed for shipment. Ill. 1000 w. *St Ry Rev*—April 15, 1898. No. 19674 C.

Combined Plant.

A Combined Street Railway and Electric Lighting Plant at Toledo, Ohio. W. S. Smith. An account of the company's experiments with different systems of motive power, and an illustrated description of its present fine station. 1800 w. *Elec Wld*—April 23, 1898. No. 19691.

Conduits.

Power Consumption on the Lenox Avenue Conduit Electric Road, New York City. G. F. Sever. Brief description of the construction and method of operation, with results of two series of tests when operated at 300- and 500-volts respectively. Ill. 1100 w. *Sch of Mines Quar*—Jan., 1898. No. 19919 D.

The Sewall Conduit on the Chicago City Railway. Describes the construction and discusses the commercial advantages. Ill. 1200 w. *Elec Eng, N Y*—April 7, 1898. No. 19430.

Dublin, Ireland.

New Construction in Dublin, Ireland. Illustrated detailed description of the Electric system of the Dublin United Tramways Co. 2700 w. *St Ry Jour*—April, 1898. No. 16421 D.

Electric Railway.

The Electric Railway. W. R. Garton. Abstract of a paper read before the Chicago Elec. Assn. Reviews the electric railway field from the earliest use to the present, touching on construction, methods, equipments, etc. 3400 w. *St Ry Rev*—April 15, 1898. No. 19672 C.

Grade Crossings.

The Protection of Grade Crossings. Concerning laws of various states, and the interlocking plants of numerous electric roads and their operation. Ill. 2400 w. *St Ry Rev*—April 15, 1898. No. 19676 C.

London Railways.

London's Internal Railways. An editorial review of London's position in regard to internal traveling facilities. 1600 w. *Engr, Lond*—April 8, 1898. No. 19649 A.

Massachusetts.

The Report of the Massachusetts Special Commission on Street Railways. Editorial discussion of this report and points suggested by it. 2500 w. *Eng News*—April 7, 1898. No. 19459.

Montreal.

Montreal Island Belt Line Railway. Illustrated description of the line with the equipment and history of the undertaking. 3500 w. *Can Eng*—April, 1898. No. 19571.

Motors.

Motor Axes and Motor Sizes. (Ueber Motoraxen und Motor Grössen.) Max Schiemann. A discussion of the relative advantages of driving one or more axles, together with the commercial advantages of various sizes of motors. 1200 w. *Deutsche Zeitschr f Elektrotechnik*—April 1, 1898. No. 19881 E.

Narrow Gauge.

The Narrow Gauge Electric Road of the Groenendijk Sugar Works, Holland. (Die Elektrische Schmalspurbahn der Zuckerfabrik Groenendijk, in Holland.) J. Werther. Illustrated description of an electric road used for conveying the sugar beets from the fields to the works. One motor car draws a train of special tipping cars. 2500 w. *Elektrotechnische Zeitschr*—April 14, 1898. No. 19892 B.

Poles.

Poles. Considers the selection, setting, painting, and practice of different roads. Ill. 3200 w. *St Ry Rev*—April 15, 1898. No. 19675 C.

Power Stations.

Some Expedients in Power Station Practice. J. H. de Gruchy. Discusses the causes of short circuits, and other matters, with devices for rapid work and for convenience. Ill. 1800 w. *St Ry Rev*—April 15, 1898. No. 19673 C.

Resistance.

Methods of Determining the Resistance of the Railway Feeder Circuits and the Ground Return Losses. Albert B. Herrick. Describes methods of making these determinations without a pressure wire. 1600 w. *St Ry Jour*—April, 1898. No. 19419 D.

Return Conductors.

The Best Arrangement of Return Conductors for Electric Railways. (Ueber die Günstigste Anordnung der Rückleitungen Elektrischer Bahnen.) Fr. Natalis. A highly mathematical discussion of the arrangement of return feeders with formulas for practical application. 6000 w. *Elektrotechnische Zeitschr*—March 17, 1898. No. 19888 B.

Sectional Conductor Systems.

Sectional Conductor Electric Railways. George T. Hanchett. Illustrated description of systems aiming at moderate cost, and a permanent way free from unsightly and dangerous devices. 3200 w. *Elec Wld*—April 23, 1898. Serial. 1st part. No. 19692.

Third-Rail System.

The Murphy Third-Rail Street Railway System. Describes the most recent attempt of avoiding overhead construction without excessive cost. Ill. 2000 w. *Elec Eng, N. Y.*—April 7, 1898. No. 19431.

Trolley Construction.

Overhead Trolley Construction on New Drawbridge in New York. Designed to give complete metallic contact for the trolley connection the entire length of the bridge when the draw is closed. Ill. 600 w. *St Ry Jour*—April, 1898. No. 19420 D.

BOOKS of MONTH



DE PONTIBUS. A Pocket-Book for Bridge Engineers by J. A. L. Waddell, C. E., B.A. Sc., Ma. E. New York: John Wiley and Sons. London: Chapman and Hall, Limited. Morocco, 416 pages.

Mr. Waddell's long study of the Latin tongue is amply justified by this short study "concerning bridges." His prefatory apology is entirely unnecessary. The curiosity excited by the delightful title is more than warranted by the contents of the volume. "Easy reading means hard writing," said Thackeray, and if it is true, there can be no doubt that "De Pontibus" is the result of hard work and harder thought, for here is found the gist of matter which might easily have occupied double the space. There is so much to commend about Mr. Waddell's work that one is troubled to select the most important parts. One feature, however, stands out prominently. The use of language and the methods of demonstration are such that they may be understood, we were almost going to say, by the multitude; certainly few, even of the least technical engineers, will fail to appreciate the meaning of the author's words, and more than this, will not only understand but will enjoy.

The introductory chapter contains valuable suggestions regarding the inappropriateness of competitive designs in bridge work, and the remarks may well be applied to some other branches of engineering.

The series of propositions, printed in large type followed by comments in smaller type, which compose the second chapter, are among the clearest presentation of principles which we remember to have seen in print.

Aesthetics in Design, Movable Bridges in General, Designing of Piers, Office Practice, Triangulation, are suggestive chapter headings, taken at random from the Table of Contents, which covers the whole subject of bridge design.

There is an excellent alphabetical index

and what strikes us as a novelty, a list of the tables, which gives also the formula from which each table is calculated.

So much for the matter; as for the manner, the book is well printed on excellent paper and is a convenient size for the pocket, but why the superfluous flap? Why not print the title on the back, round the corners, and so make a book which is more suited both to the library and the pocket than this form is to either?

THE MARINE STEAM ENGINE. A treatise for Engineering Students, Young Engineers, and Officers of the Royal Navy and Mercantile Marine. By the late Richard Sennett and Henry J. Oram. London, New York and Bombay: Longmans, Green & Co., 1898.

Sennett's treatise on the marine engine has long been known as a standard authority and the eminent position occupied by the author as well as the thorough and reliable character of the work have made it for many years one of the indispensable books of reference in the branch of engineering of which it treats.

Since the appearance of the last edition which had the revision of Mr. Sennett himself, in 1885, many changes have taken place in the practice of marine engineering, and while the older editions of the work will always have a historical interest, they are now altogether too far behind present practice to be of immediate service. It is, however, a most graceful tribute to the memory of the deceased author to place his name upon the title page of this book in connection with that of Mr. Oram, as the work has been so thoroughly rearranged and rewritten that the latter gentleman might well have claimed the authorship alone.

In this connection it is interesting to quote the introductory note of Sir John Durston, the present engineer-in-chief of H. M. Navy, in which he says: "To the many who knew the late Richard Sennett, my old friend and predecessor in office, and appreciated his work and worth, and

regretted the all too early closing of his brilliant career, it will be a source of gratification that the revision of this book has been undertaken by so capable a marine engineer as Inspector of Machinery H. J. Oram, R. N.

"Mr. Oram has acquired a vast amount of special knowledge and experience of marine machinery of the latest types, and it is believed this has been incorporated in the present edition in a manner that will make it of great value to students, young engineers and officers of the Royal and mercantile navies in carrying on their studies and duties."

An examination of the book proves that Sir John Durston's commendation has been fully warranted; the work being fully up to date in many points upon which until now no collected information has been available. The brief historical introduction is followed by a classified and systematic treatment under the main divisions, The Boiler; The Steam; The Mechanism; The Propeller; and General; each of these being again divided into chapters giving a sub-classification.

It is impossible here to give a detailed review of the very full treatment of the subject which Mr. Oram has given, but some points are especially worthy of mention. The marine boiler is treated according to the efficiency obtained, computed from the total calorific power of the fuel used, this method being now in general use in land tests, and such recent data as the tests of the Powerful are included in the discussion. Liquid fuel is given place, and water-tube boilers have an entire chapter, with many illustrations and descriptive details. Radial valve gears are shown, and many arrangements of cylinders for various designs of multiple expansion engines. The very full treatment of the construction and arrangement of engine details forms a characteristic feature of the work, and it is in just such a point that a more general treatise is apt to be deficient. The vital point of auxiliary machinery is not neglected, and altogether it is not too much to say that the work is the latest exposition of the modern science and practice of marine engineering.

THE CALORIFIC POWER OF FUELS. By Herman Poole, F. C. S. New York: John Wiley & Sons; London: Chapman & Hall, Limited. 1898.

Mr. Poole has set out to give us an English version of Scheurer-Kestner's treatise on the *Pouvoir Calorifique des Combustibles*, but the work has grown on his hands and the result is almost a new book, based indeed on the work of the French author, but containing much that adds to its value.

There has been need for some time of a good treatise on the practical applications of calorimetry, especially since the general disposition of mechanical engineers to rate steam generators by their efficiency of performance has continued to call for some adequate method of determining the correct calorific power of any given fuel. Papers have been presented before engineering societies, and discussions have been most animated, but any one who really wanted to know something about the subject from a practical standpoint was obliged either to have recourse to foreign authors or else dig out from the scattered transactions of technical associations the information required.

Mr. Poole has now collected the matter into a convenient and satisfactory shape, and beginning with the various forms of fuel calorimeters for solid and gaseous fuels he passes on to the practical use of both calorimetric and chemical tests, concluding with the allied subject of gas analysis. A valuable set of tables follow, and the book is well indexed.

LA PHOTOGRAPHIE ET L'ETUDE DES NUAGES. Par Jacques Boyer. Paris: Charles Mendel. 1898.

The application of photography for recording fleeting scientific phenomena is becoming more and more general, and its use in connection with the difficult branch of meteorology which deals with the study of the clouds has enabled a much more rapid advance to be made than has hitherto been possible.

The international meteorological congress placed this subject in the hands of the directors of a number of the best known observatories for the purpose of collecting and classifying the negatives obtained from many sources, and this work having terminated at the close of the year 1897

makes Professor Boyer's little work timely and appropriate.

Apart from the interest which these studies have for physicists and meteorologists there is much of engineering value in the arrangement of the photographic theodolites and the methods of determining the altitude of cloud strata at the time of photographing. In this respect the subject bears a close relation to the modern art of photographic surveying, and the two allied applications of photography to the science of exact measurement will undoubtedly be of mutual assistance and value.

Professor Boyer's discussion of the subject is therefore well worthy of perusal by engineers as well as physicists, and the clear and scientific manner in which he has treated it will add to his already high reputation.

BOOKS RECEIVED.

Alternate Currents in Practice. Translated from the French of Loppé and Bouquet by Francis J. Moffet, B. A. (Lond.) London and New York: Whittaker & Co. 1898.

The Journal of the Iron and Steel Institute. Vol. LII. Edited by Bennett H. Brough, Secretary. London: E. & F. N. Spon. New York: Spon & Chamberlain. 1898.

House-Drainage and Sanitary Plumbing. By Wm. Paul Gerhard, C. E. Seventh Edition. Van Nostrand's Science Series. New York: D. Van Nostrand Company. 1898.

Interstate Commerce Commission. Ninth Annual Report on the Statistics of Railways in the United States, for the year ending June 30, 1896. Prepared by the Statistician to the Commission. Washington: Government Printing Office. 1897.

Annual Report of the Minister of Mines for the year ending 31st December, 1897, being an account of mining operations for gold, coal, etc., in the province of British Columbia. Victoria, B. C.: Printed by Richard Wolfenden, Printer to the Queen's Most Excellent Majesty. 1898.

Proposed Sea Water Fire Pipe Line for the City of New York. Reports of Chief of Department Hugh Bonner and Consulting Engineer Foster Crowell. New York: 1897.

The Georgian Period, being Measured Drawings of Colonial Work. By Frank E. Wallis, David A.

Gregg, and others. Part I. Portfolio of 33 plates. Boston: American Architect and Building News. 1898.

Proceedings of the Annual Meetings of the Pacific Coast Gas Association, 1893-1897. Oakland, California: Oakland Enquirer Publishing Co. 1897.

American Gazetteer of Power Plants in the Principal Cities and Towns of Pennsylvania for the year 1897. Cleveland, Ohio: American Gazetteer Co. 1897.

Coal Catechism. By William Jasper Nicolls, M. Am. Soc. C. E. Philadelphia and London: J. B. Lippincott Co. 1898.

The Designing of Cone Pulleys. A Non-approximate, Graphical Solution for the Problem of Proportioning Cone Pulleys. By Walter K. Palmer, M. E. Lawrence, Kansas. 1898.

Notes on Heat and Steam. By Charles H. Benjamin, M. E. Cleveland, Ohio: Charles H. Holmes. 1898.

The Traction Engine, its Use and Abuse. By James H. Maggard. Philadelphia: David McKay. 1898.

A Treatise on Magnetism and Electricity. By Andrew Gray, LL.D., F.R.S., Vol. I. London: Macmillan & Co., Limited. New York: The Macmillan Company. 1898.

Workingmen's Insurance. By William Franklin Willoughby, United States Department of Labor. New York and Boston: Thomas Y. Crowell & Co. 1898.

Hydraulic and Placer Mining. By Eugene B. Wilson. New York: John Wiley & Sons. London: Chapman & Hall, Limited, 1898.

Gas, Gasoline and Oil Vapor Engines, For Stationary, Marine and Vehicle Motive Power. By Gardner D. Hiscox, M. E. New York: Norman W. Henley & Co. 1898.

The Storage Battery, A Practical Treatise on the Construction, Theory and Use of Secondary Batteries. By Augustus Treadwell, Jr., E. E. New York: The Macmillan Company. London: Macmillan & Co., Limited, 1898.

The Calorific Power of Fuels, Founded on Scheurer Kestner's Pouvoir Calorifique des Combustibles. By Herman Poole, F. C. S. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

The Resistance and Propulsion of Ships. By William F. Durand. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

The Purification of Public Water Supplies. By John W. Hill. New York: D. Van Nostrand Company. 1898.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

United Ordnance and Engineering Co., Ltd., with which is incorporated Messrs. Easton, Anderson, and Goolden, Ltd., Erith, England. = Handsome catalogue of multipolar continuous current dynamos and motors; with description of mode of manufacture, with full dimensions, prices, illustrations, and description.

Adolphe Crosbie, Ltd., Wolverhampton, England. = Catalogue of paints, oxide pigments, varnishes, etc., with samples of work, and prices.

Lucas & Davies, 67 Farringdon Road, London. = Illustrated price list of working models of stationary, locomotive and marine engines and boilers.

J. & F. Havard, Britannia Iron Works, Bedford, England. = Catalogue of agricultural implements, oil engines and light railway rolling stock, fully illustrated with prices and all usual particulars.

Humpidge, Holborrow & Co., Ltd., Stroud, Glos., England. = Price list of the Dudbridge gas engines up to 25 h. p., with prices and half tone illustrations.

Beaumont's Pump Works, Stockport, England. = 8 page illustrated price list of the "Rapid" centrifugal pumps and the Beaumont water lifter, with directions for fixing.

Jas. B. Petter & Sons, Nautilus works, Yeovil, England. = (a) Illustrated price list of the "Destructor" kitchen ranges; (b) specimen order form.

Hartley & Sugden, Ltd., Halifax, England. = Handsomely illustrated catalogue and price list of welded boilers with automatic regulators for the steam heating of buildings; also French edition with dimensions in metrical system. Fully coded.

W. J. Wells Smallfield, Horley, Surrey. = Sheet price lists (a) of gas and oil engines; (b) of calcium carbide bicycle lamps.

Julius Harvey & Co., 11 Queen Victoria St., London, E. C. = Illustrated price list of mining machinery, including gold crushing plant, light locomotives and pumps.

Lee Howl & Co., Ltd., Tipton, Staffs., England. = Export catalogue of steam, rotary and force pumps; fully coded and priced for each machine, with abbreviated specifications.

Woods & Co., Suffolk Iron Works, Stowmarket, England. = Catalogue of agricultural machinery; also of wagons and carts. Fully illustrated, with usual data as to sizes, prices, etc.

Smith and Grace, Thrapston, England. = Catalogue with illustrations, particulars and prices of Smith's patent screw boss pulleys; also of couplings, pedestals, hangers and shafting accessories.

Smedley Bros., Ltd., Eagle Iron Works, Belper, England. = Illustrated catalogue of edge runner grinding mills. $8\frac{1}{2} \times 11$ ". Paper cover 24 pp.

Thos. H. Dallett & Co., Philadelphia, U. S. A. = Handy catalogue of portable power and electric drills, boiler shell drills, hand drills, electric portable planers, flexible couplings, and special machinery. Many illustrations of these convenient tools, with descriptive data and extensive list of users.

Foster Engineering Co., Newark, N. J., U. S. A. = Catalogue of steam specialties, including the Foster pressure regulator, pump governors, safety stop valves, check valves and other high-grade specialties for steam, water, air, or gas.

The Diamond Rubber Co., Akron, Ohio, U. S. A. = Pamphlet catalogue of mechanical rubber goods, belting, hose, sheet packing, piston packing, diaphragms, &c.

Sullivan Machinery Co., Chicago, Ill., U. S. A. = Handsome catalogue of the various forms of the Sullivan Diamond Prospecting Core Drill, showing examples of its successful use in coal and metal mining in all parts of the world.

Also catalogue of the Sullivan rock drills and channelling machines, as used in mining and quarrying.

Stanley G. Flagg & Co., Philadelphia, Pa., U. S. A. = Descriptive catalogue of steel, malleable iron, and gray iron castings, with directions as to the various uses to which they may be put, instructions with regard to patterns, and description of the qualities possessed. A priced and illustrated list of special steel bicycle parts is also given.

New Haven Mfg. Co., New Haven, Conn., U. S. A. = A handsomely illustrated catalogue of machine tools, including lathes, planers, drills, slotters, and smaller tools; with a special telegraphic code.

Queen & Co., Incorporated, Philadelphia, Pa., U. S. A. = Illustrated catalogue of engineering instruments and materials. The list covers transits, theodolites, levels, compasses, sextants, and many forms of minor instruments used by the engineer and surveyor.

Sprague Electric Company, New York. = Electric Motors in the Art of Printing. A most beautiful specimen of the printer's art, illustrating the adaptability of various forms of the Lundell motor to printing office work. Valuable data from tests are given to show the saving in power loss over belting and shafting. Also catalogue of the Lundell fan motors, another handsome piece of typography.

Almy Water-Tube Boiler Co., Providence, R. I., U. S. A. = A general catalogue of the Almy water-tube boilers, giving dimensions and illustrations of the various styles, and also comparative evaporative tests made by well-known experts.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Instructive pamphlet on friction and lubrication, showing the special value of flake graphite as a lubricant.

Chicago Mining Machine Co., Chicago, Ill., U. S. A.=A valuable pamphlet describing machines for the recovery of gold from placer gravels and particularly applicable to placers having no dump and a very small water supply. The characteristics of gold deposits and the methods of extracting gold are treated in a clear and scientific manner.

Henry E. Pridmore, Chicago, Ill., U. S. A.=A descriptive pamphlet of the Pridmore molding machines, with photographs of the machines and an account of the Pridmore method of molding by machinery in the foundry.

The Charles B. King Co., Detroit, Mich., U. S. A.=Catalogue of the King gasoline engines, especially showing their adaptability to marine launches.

Jarvis Manufacturing Co., Chicago, Ill., U. S. A.=A pamphlet illustrating the Jarvis sliding grate, and showing its adaptability to locomotive, marine, and stationary boilers. A series of successive views show the manner in which the sections rock and slide between each other.

Philadelphia Machine Tool Co., Philadelphia, Pa., U. S. A.=Neat little pocket catalogue of special machinery for working sheet metal, including punching, embossing, and drawing presses, and other special tools.

U. S. Wind Engine & Pump Co., Batavia, Ill., U. S. A.=Handsome catalogue devoted to railway water supply, with description of tanks, wind engines, pumps and connections.

The Bucyrus Company, South Milwaukee, Wis., U. S. A.=Catalogue Part VII. Placer mining machines. A handsomely illustrated catalogue of the powerful mining dredges for use in placer work, built by this well-known company, with much important and valuable descriptive matter relating to this growing line of work. Placer mining shovels for dry work are also shown. An important and valuable catalogue.

Baldwin Locomotive Works. Burnham, Williams & Co., Philadelphia, Pa., U. S. A.=Record of recent construction. Successive illustrated pamphlets, giving photographs and specifications of current work as completed for various railroad companies. Four parts received to date, forming instructive exhibits of the products of the establishment.

William H. Bryan and Henry H. Humphrey, St. Louis, Mo., U. S. A.=Pocket catalogue of references to clients for whom mechanical and electrical engineering work has been done, showing the extent and character of business undertaken.

Boston Belting Company, Boston, Mass., U. S. A.=Special circular of "Excelsior" gasket tubing, and sample of proprietary label by which it is identified.

The W. J. Clark Co., Salem, Ohio, U. S. A.=Illustrated Catalogue and Price List No. 22. A very full and complete catalogue of the "Salem" elevator buckets and other elevating and conveying specialties.

Chas. A. Schieren & Co. New York.=Big Belts. Pamphlet folder, containing lists of large leather belts sold for use in various parts of the world. Also, "Dixie Belt Leather," a handsomely illustrated pamphlet describing the firm's tannery at Bristol, Tenn., U. S. A.

The John F. Byers Machine Co., Ravenna, Ohio, U. S. A.=Extensive catalogue of portable and semi-portable steam hoisting engines, derricks and similar appliances for use of contractors and quarrymen. A useful catalogue for preservation and reference.

B. T. Sturtevant Co., Boston, Mass., U. S. A. Sturtevant Engineering Co., London.=Illustrated catalogue of the Sturtevant engines for electric light plants and general high-grade work. A beautiful specimen of typography, containing much useful information about these standard engines, making it a desirable reference catalogue.

Illinois Steel Company, Chicago, Ill., U. S. A.=Pamphlet catalogue describing the process of the manufacture of mineral wool from furnace slag, and showing its applications for insulation in cold storage, and as a filling material in building construction.

The Reeves Pulley Co., Columbus, Indiana, U. S. A.=Catalogue B, describing and illustrating the Reeves wood-split pulley clutch with cipher code, and price list of Reeves patent clutch pulleys.

The Winton Motor Carriage Co., Cleveland, Ohio, U. S. A.=Descriptive catalogue of handsome motor carriages, operated by hydrocarbon motor.

Houston, Stanwood & Gamble, Cincinnati, Ohio, U. S. A.=Pocket catalogue of H-S-G plain slide valve engines, setting forth the advantages of this type when properly built and intelligently used.

Lee-Penberthy Mfg. Co., Detroit, Mich., U. S. A.=Manual of useful and valuable information such as discount tables, pipe tables, railroad distances, &c., convenient for users, sellers, and manufacturers of steam goods and kindred lines. A most useful and convenient pocket manual, containing a great amount of valuable information condensed into a compact and convenient form. Much of the matter is based upon exhaustive tests, and the whole forms a book which should be in the hands of every working engineer.

THE
ENGINEERING MAGAZINE

VOL. XV.

JULY, 1898.

No. 4

SEA POWER AT THE END OF THE NINETEENTH CENTURY.

By W. Laird Clowes.

THERE is coming a time when sea power, meaning what it now means, will cease to exercise a dominant influence upon the political and commercial affairs of the world. Instead of the sea, the air must some day become the great international highway for trade and travel ; and, when that consummation shall have been reached, the immemorial laws which were enunciated by Cicero, Hungerford, Raleigh, Bacon, and Vernon, long before they were codified and annotated for us by Mahan, will no more affect human transactions. It is very probable that the age which shall witness this deposition of the sea from its ancient strategic supremacy will witness also the practical realisation by mankind of the fact that the sea contains, stored within it, other sources of wealth and dominion. We have as yet scarcely begun to utilise the energy of the tides and the currents ; and it may well happen that, when our argosies and fleets traverse the air instead of the water, the ocean shall furnish us with the raw force which we shall tame and harness to our aerial ships. But, at present, we are, apparently, little nearer to this—to my mind inevitable—development than we were when the brothers Montgolfier sent up their first balloon. In other words, the supremacy of sea power, threatened though it has been ever since 1783, is likely yet to stand firm for many years,—possibly for many generations. Thus far, at least, its position has not been shaken.

Although, nevertheless, sea power still means all that it ever signified, and although it is even a more desirable possession to-day than it was in the past, it is necessary to bear very clearly in mind that the conditions under which sea power can be exercised have in recent years undergone remarkable and rapid changes, and that the process

Copyright, 1898, by John R. Dunlap.

of change becomes yearly more and more rapid. To put it otherwise, several of the factors which now go to build up sea power are quite different from what they were half a century ago, and not quite the same as they were so recently, let us say, as last winter. Every war, almost every discovery or invention, every political revolution, every considerable commercial movement, modifies, more or less, the terms upon which sea power is to be grasped and held. In the days of Nelson—as at any time during the previous two hundred years—the terms were comparatively simple and few, and relatively immutable from generation to generation. The main factors were commerce, fleets, the outlying possessions of a nation, geographical position, personnel, and mobility. Commerce was, as it still is, the true mother of sea power, and it had to be protected; but in those days the temporary dislocation of commerce never meant half what it means now. Nearly all countries were self-supporting, except in the matter of pure luxuries; and they could make shift to struggle on for a season without supplies from abroad. Fleets could then be built with equal ease and speed in almost any civilised land, and it was very rare indeed for a country to obtain her men-of-war, or the weapons wherewith to arm them, from abroad, except by process of capture. Nor did the fleets of different powers, different builders, and different generations vary very much. From the material point of view a Spanish three-decker was as good as a French or a British one; and a ship, when once built, continued, if taken care of, to be fully fit for the kind of service for which she had been originally designed, until she was destroyed or fairly worn out. The *Victory*, a crack ship in 1805, and even several years later, dated from 1765; and there were in active commission at about the time of Trafalgar much older men-of-war than she was. In those days oversea possessions were all, or nearly all, mere dependencies. The self-governing colony was unknown; the manufacturing colony was still awaiting development; the colony as a field for the investment of immense capital was almost undreamed of. As for geographical position,—at first sight, surely, a most immutable factor,—it possessed a significance which it has since partially lost. In the days before the advent of steam, the ability of a ship or of a fleet to leave or make a given port depended to a large extent upon the prevailing winds; and problems connected with blockade, invasion, and combined movements were thus placed upon bases altogether different from those which they now occupy. It was possible, for example, for Bridport or St. Vincent to lie for weeks together at Spithead or in Torbay, assured that the Brest fleet was safe in its harbour, if only for the reason that the wind was such as prevented it from coming out. Even the personal problem was, relatively, a plain and easy one in

the old days. It was often necessary, it is true, to offer extravagant bounties, and to resort to the iniquities of the press, in order to procure such men as were needed in excess of the ordinary peace establishment, whatever it happened to be ; yet, when the men had been obtained, the problem was much more than half solved ; for it was possible, in six or even in four months, to train the rawest landmen to become very respectable man-of-war's men.

All the factors of sea power which I have so far glanced at have entirely altered in character, and in their relationship both to one another and to the whole situation, since the wars of the early part of the present century. The result is that, although, like the laws of electrical energy, the laws of sea power are really exactly the same as they were in the days of our grandfathers, sea power, like electricity, cannot now be understood and fully taken advantage of, unless it be looked at in the light of knowledge, and directed by methods and machinery, of which our grandfathers never dreamed. As far as electricity is concerned, this truth is, of course, the dullest platitude. But it is not, I think, a platitude as regards sea power. Electricity is a force the practical application of which is hourly and anxiously studied by numbers of trained and experienced intellects. Sea power, on the other hand, is a force the practical application of which has received hardly any attention. We have been told, by Mahan and others, what sea power is, and what sea power has effected and may yet effect ; and we are from time to time assured that intelligence departments and boards of strategy are at work on the elaboration of plans of naval offence and defence with regard to special situations and eventualities. But we have no reason to believe, and every reason to doubt, that the broad problem of the bearing, upon the laws of sea power, of modernised factors and of altogether novel conditions has ever yet been intelligently and scientifically studied. The time for the scientific study of the application of sea power has surely arrived, unless, indeed, our recent awaking to the influence of sea power upon past history is to be of no practical benefit whatsoever to the science of war, and of no utility to the cause of peace.

I daresay that I shall be charged with having overstated the case, and that I shall be told, firstly, that the subject already receives sufficient attention, and, secondly, that, after all, there is little to be studied in connection with the matter. Nevertheless, if space permitted, I could, I think, by taking *seriatim* each of what I have ventured to call the main factors of sea power, show that, to this day, those powers which have navies, and which aspire to make use of them, are proceeding almost as blindly, as unsystematically, as un-

scientifically, and as uneconomically as they could proceed if no intelligent appreciation of the laws and influence of sea power were open to them. Nay, more, I could, I think, convince my readers of the correctness of my contentions. Since space does not permit, I will confine myself to the consideration of a single point by way of illustration.

I have mentioned, among the main factors of sea power, mobility. It is now one of the most important factors, because it is a factor in which it is possible for any naval nation—even one of the third rank—to crushingly excel its bigger rivals. In the old days mobility had not quite its present importance, and certainly it had not anything like its present possibilities. One line of battleship might then be faster than another, but not much faster; one constructor might build quicker than another, but not much quicker; one fleet—care and foresight being equal in both—might keep the sea longer than another, but not much longer. Given equality of numbers and personnel, two navies were then necessarily very much on a dead level, until the weather interfered; and the weather, inexorably and impartially, by turns aided and hampered both. The weather is not the only element which has now ceased to have its old influence upon the factor of mobility, but, in order that we may fully grasp the extent to which the conditions have altered, and how unequally they now influence different countries, we must stay to enquire what mobility, as one of the great factors of sea power, means.

It means, broadly and briefly, the digested science and practice of creating with the greatest possible promptitude the best and newest engines of naval warfare; of moving those engines with the highest possible intelligence and rapidity to the points at which they shall be capable of rendering the greatest service; and of preserving those engines in all circumstances in the best possible state of readiness and efficiency. Analysed more strictly, the elements of naval mobility are: facility for rapid manufacture and construction; quick collection, collocation, and dissemination of intelligence; a fast working mobilisation system; ships of high speed and coal endurance; and organised machinery for the speedy making good of waste and expenditure.

In the days of wooden ships, all the naval powers could, at a pinch, build with about equal rapidity. A vessel could be laid down upon almost any beach that sloped into moderately deep water; and the foundries and shops of any country, save the most insignificant, were fully equal to the fitting and arming of the finest three-decker. But, in these days of steel, some countries, unless they import nearly all their materials in manufactured form, cannot build a battleship at

all ; and none can build battleships, or even smaller men-of-war, except in particular localities. Some cannot complete a battleship in less than five or six years ; others can do it in two, and can even finish a large cruiser in one. Some make their own guns and ammunition ; others cannot do so, and have to import part or all of what they need. In their ability to obtain, collocate, and disseminate intelligence, the various naval nations start with more equal advantages. In peacetime, at least, all have equal command of *attachés*, secret agents, technical advisers, the posts, and the telegraphs. There are very few naval secrets ; and the majority, even of those few, are practically open ones. Such advantages as these lie with the wealthier and better-educated States ; but, for all, the business of the intelligence department is immeasurably a simpler matter than it was in the days when international intercourse was difficult, and when such things as a cheap press, special correspondents, and submarine cables were unheard of. Mobilisation also is a far easier thing than it used to be. Telegraphs, steamships, and railways facilitate it immensely. But all countries do not possess equal facilities for it. The facilities must, to a large extent, depend upon natural conformation, and upon the proportion borne by the telegraph and railway mileage to the area of the land. Speed is the element which has most influenced the factor of mobility. The limit of speed in the old days was, for a frigate, about fifteen knots, and, for a line-of-battleship, about twelve. No ability on the part of the constructor, and no expenditure on the part of his employers, could produce much greater speed than that ; and even that could be attained only in the most favourable conditions. An adverse gale might mean the impossibility of any progress at all. We do not know what are now the limits of speed. We know only that we have not yet attained them, and that we have already attained speeds up to about thirty-six or thirty-seven miles an hour in smooth water. In the meantime, we have large ocean steamers which do their twenty-two knots, in good weather and bad, with almost the punctuality of railway trains, and which are capable of carrying coal to take them more than half way round the world at that speed. Just as all countries have not equal facilities for building modern warships, so all countries have not equal facilities for building vessels of extreme speed. And, apart from purely military purposes, it is worth the while only of those countries which have extensive sea-town commerce, and large commercial marines, to build or purchase ocean greyhounds of the fleetest types. In point of fact, all the fastest liners and merchantmen in the world belong, or belonged until the last few weeks, to Great Britain, Germany, the United States, and France ; and all the fastest men of-war in the world have been constructed either in Great Brit-

ain, Germany, the United States, Italy, or France, or by workmen of those countries. As for organised machinery for the speedy making good of waste and expenditure, it is now much more difficult to create it than was the case in the old days. Ships are less self-contained than they used to be. They need continual supplies of coal; in action they expend their ammunition much more rapidly than of yore; and they are of more delicate constitution than their wooden and masted predecessors. Moreover, coal, like steel, is not produced everywhere. Some countries can dig it; others must buy it; and, as it is the very life of every man-of-war, it is indispensable. Again, the commercial countries can handle and transport it, and other necessary supplies for a fleet, more readily than the uncommercial ones; and the shipbuilding and commercial countries have, of course, the best facilities for keeping their men-of-war in permanent efficiency, both as regards material condition and as regards fuel and stores.

Now let me come to my point, which is, as has been said, that, although, in these closing years of the nineteenth century, we understand better than ever the laws of sea power, and the manner in which sea power has influenced history, and must for the present continue to influence it, we have not as yet seriously studied and made a science of the application of sea power under modern conditions.

There is, I believe, no country, save perhaps Germany, wherein the theory of modern naval warfare has received more attention than in the United States. The navy department has for years been most admirably served abroad by a large body of naval *attachés* of exceptional energy and ability; much of the intelligence collected by these *attachés* is from time to time embodied in the invaluable series of volumes entitled "Information from Abroad," and is thus circulated throughout the United States navy; the Naval Institute at Annapolis disseminates other professional literature, superintends the discussion of all important questions connected with service matters, and keeps its members constantly supplied, as it were, with a mirror of the world's thought and work on naval subjects; and, in the naval war college, America has had the advantage of a strategical and tactical school such as had never existed elsewhere. If, therefore, any country is in a position to understand the methodical application of sea power, it should be the United States. But the truth unfortunately is that neither there or elsewhere are either the citizens or the government officials as yet capable of deducing from the facts at their disposal the lessons which are patent enough to thoughtful naval officers and to intelligent specialists. In constitutional countries, a navy is what it is,—large or small, efficient or inefficient,—not in pursuance of the will of the officers, but in pursuance of the will of

the nation. Since there is now growing up, almost everywhere, a keen popular appreciation of the value of sea power, I do not give up hope that, in the future, there may also grow up a popular realization of the modern problems affecting the application of sea power. But that time is not yet; and meanwhile we are wasting half of the huge sums which we annually spend for naval purposes, simply because we do not know how to spend them intelligently.

If what I say were not true, how different would have been the opening incidents of the Hispano-American war! It must now be evident to all that neither side applied in the right way and to the best advantage such sea power as it possessed. Let us, in continuation of what I have already advanced, glance at the attitude of the combatants with regard to the single factor of mobility. As between the United States and Spain there is no question that the former country ought to have held and played all the trumps in this particular hand of the game. She held the trumps, indeed, but, apparently, she did not know how to play them. She has for years possessed immeasurably greater facilities for rapid manufacture and construction; she has for years had at her disposal better machinery for the quick collection, collocation, and dissemination of intelligence; it is her own fault,—supposing it to be the case,—if her system of mobilisation is the slower-working of the two; there is no reason why any of her ships of war should be of lower speed and worse coal-endurance than those of a poor country, like Spain; and, moreover, she actually had at her command, at least up to the moment when war became imminent, more fast merchant ships than Spain. Finally, she has long had at hand far better materials than Spain for creating an organized machinery for the speedy making good of waste and expenditure.

Looking to all these considerations, I do not hesitate to say that, on the strength alone of her vastly superior capacity for mobility, the United States ought—had she known how to apply this great factor of sea power, and had she so applied it—to have reduced her enemy to impotence within a few days of the outbreak of the war. That she did not do so was her fault, not necessarily Spain's merit, although certainly Admiral Cervera seems to have displayed much strategic ability.

Every American realizes, more or less vaguely, that it is necessary for a country so large and so important as the United States to possess a navy. But American public opinion, when, about twelve years ago, it came to the conclusion that it must have a navy of modern construction, was not sufficiently intelligent to put to itself certain weighty questions. It did not ask itself: "Is it not likely that some

day we shall have to meet European opponents? Is it not a maxim of naval, and, indeed, of all, warfare that the only good defence is offence? Is it not also a maxim of naval warfare that your enemy's coasts are the most effective fighting-ground for your fleets? Is it not a fact that, seeing that America is very far distant from any of the great naval countries, her war ships, which may have exceptional distances to traverse, should have exceptional speed and exceptional coal capacity?" On the contrary, American public opinion, not having studied the science of the application of sea power, demanded comparatively few fast ships, gave to the majority even of these no very exceptional coal endurance, and positively insisted that its heaviest and most formidable ironclads should be fitted rather for the defence of the coast-line of the United States than for operations in the waters of the far-off foe. Thus did American public opinion cripple in its infancy the mobility of the new American navy. A few faster and more enduring ships have been built since; but much time was lost, and much money was wasted. Nevertheless, even when war became imminent, America had it in its power to partially compensate for the defective mobility of the bulk of its fighting fleet. It had it in its power to buy up and to utilise a very large proportion of the fastest ocean liners of the world. It hastily purchased several; but it can hardly be said that it utilised them properly. The best part of the Spanish fleet was still in Spanish ports. It could be found when wanted. It should surely have been watched from the beginning, and destroyed so soon as it ventured to sea. And it might have been. To make up for the relatively small coal-endurance of the majority of United States men-of-war, the Canary Islands might, if desirable, have been seized to serve as a coaling base; the heavy ships, accompanied by colliers, might have been stationed there; and the fast ships and the mercantile cruisers might have been stationed off Cadiz and Ferrol, so that nothing could escape without the fact and all necessary particulars being promptly reported to the battle-ship squadron. But nothing of this sort was attempted; nothing of this sort was apparently even contemplated by the United States government and by American public opinion. I am sure that it was contemplated, and I suspect that some scheme of the kind was urged, by many naval officers; but public opinion would not have allowed such a plan to be carried out. The people, knowing nothing of the application of sea power, would have insisted that the proper station of the main fleet was on the western side of the Atlantic. The consequences were that the fleet of Cervera was able, unwatched, to leave its ports, and to make rendezvous at the Cape de Verdes; that it was able to disappear thence, the Americans

knew not whither ; that some of the Atlantic coast-towns of the Union, imagining that the Spaniards were about to raid them, were seized with panic ; that the safety of the Oregon, coming from the Pacific, and of the *Nichteroy*, coming from Rio de Janeiro, was for a time almost despaired of ; that Cervera, after having remained invisible for a fortnight, turned up in the very waters which he should never have been allowed to reach ; that, for another fortnight, he remained in those waters without the Americans being able to bring him to action ; and that, on more than one occasion when the Americans had a chance of catching him, they were rendered temporarily impotent by the condition of their bunkers, and by their inability to fill up with fuel without going to Key West. Delay, anxiety, and expense were the penalties paid by the Americans for their neglect to use from the beginning, and to the utmost, all the advantages of mobility which were, or which, had they willed it, might have been, at their command. Neglect of this kind, especially at the commencement of a war, does not, as we have often seen in the course of British history, necessarily jeopardise the ultimate issue ; but it postpones it, and it makes it many more times costly, in blood as well as in treasure.

I have ventured to use these episodes of the Hispano-American war as illustrations of my contention that we have not as yet seriously studied and made a science of the application of sea power under modern conditions : but far be it from me to suggest that America is in this respect different from other naval nations. All equally neglect the importance—the supreme importance—of speed and promptitude in every matter connected with the organisation and handling of a modern naval force. We have seen recently how the British admiralty took a fortnight to mobilise Admiral Dale's particular service squadron, when, according to its previous declarations, it ought not to have taken more than three or four days ; how it went to sleep over the armour question, and, dreaming that certain armour was temporarily unobtainable, announced it as a fact ; and how, in spite of its facilities for acquiring information, it had to be set right by the morning papers on the subject of the number of men-of-war under construction for Russia. We have watched, too, the weary voyage of the *Deutschland* to the far east. Upon the whole, there are probably few powers which, at the test, would do much better than America has done.

Yet that reflection is only negatively satisfactory. We may be sure that the unscientific method of preparing for war and of waging it is always, in the end, the most expensive way ; and we may take it that, while no factor of sea power can be neglected with impunity,

the neglect of no factor is so fraught with danger, suspense, anxiety, and waste of money as the neglect of that group of elements which I have classed as constituting mobility. Those elements are all of great importance; but at the head of them stands, undoubtedly, speed,—locomotive speed,—with, as its complement, coal endurance. We are told that every warship is, of need, a compromise. But there are wise compromises and foolish ones. The compromise which, in any serious degree, sacrifices speed to guns, armour, and magazine capacity, seems to me to belong to the latter category. The lesson of all recent naval wars is that the point upon which it is most perilous to make concession is the point of speed. The battle of Angamos, the battle of Hai-yun-tau, the westward voyage of Cervera, lead to the same conclusion; and so plain does this conclusion appear to my mind that I am inclined to regard it as little better than waste of money for a naval power now-a-days to deliberately design and lay down any vessels which shall have less speed than vessels of corresponding classes in the navies of other nations. If France builds, as she is actually building, an armoured cruiser to do her 23 knots, the new armoured cruisers of Great Britain should surely be 23-knot, if not 24-knot, vessels, and not, as will be the case, 21-knot craft. And so with battleships, protected cruisers, and torpedo-vessels. You cannot afford to compromise on the element of speed to a greater extent than your neighbours have compromised or are compromising. Some powers have already begun to realise and to act upon this truth. The Argentine Republic—though, in common estimation, but a fourth-rate State—has spared neither pains or expense to acquire the fastest cruisers in the world. In the Buenos Aires, the Nueve de Julio, and the 25 de Mayo, she has three ships which no other country can parallel. Chile, also, has started upon the same wise course. Fast ships are naturally of little value, unless there be behind them knowledge and organisation, and in them science and bravery; but we may be sure that, other things being approximately equal, speed will tell more than any other single factor in the naval warfare of to-day and to-morrow; and we may, I think, rest assured that, although speed is one of the most expensive requirements of a navy, it is, in the long run, the most economical, because it is the most time-saving, anxiety-saving, and money-saving quality with which we can endow a warship.

In certain classes of her ships Great Britain has neglected speed more than most naval nations; and it would be well if the country would quickly rouse itself to this fact, and insist upon a change of policy. I do not, of course, speak of her torpedo-boat destroyers, which, at present, leave nothing to be desired. I speak of her bat-

tleships and her cruisers, and particularly of the latter. We are accustomed to think of the Powerful and Terrible as cruisers of exceptional speed as well as of exceptional force : but in reality, considering their immense displacement, they are both slow and weak. Compare one of them, for example, with the Buenos Aires above mentioned :

	<i>Terrible.</i>	<i>Buenos Aires.</i>
Displacement, tons	14,200	4,500
I. H. P. (nat.)	25,000	13,000
Mean trial speed (nat.), knots	22.4	23.2
Coal capacity, tons	3000	1000
Heaviest armour over guns, ins	6 in	4.5
Torpedo-tubes	4	5
Guns	2—9.2 in. B.	2—8 in. Q. F.
	12—6 in. Q. F.	4—6 in. Q. F.
	16—12 pr. Q. F.	6—4.7 in. Q. F.
	12—3 pr. Q. F.	4—6 pr. Q. F.
	9—.45 in. Maxims	10—3 pr. Q. F.
		6—1.4 in. Maxims
Weight of double broadside, lbs.	2190	1150
Muzzle energy of double broadsides, lbs.	70,000	53,300

The Terrible, therefore, though three times as big, and consequently perhaps about three times as costly, as the Buenos Aires, is nearly a knot slower under natural draught ; carries less than 50 per cent. more coal per i. h. p. ; has fewer torpedo-tubes ; throws less than double the weight of broadside ; and throws that broadside with only about 35 per cent. more muzzle energy. In addition, the Terrible is vastly the bigger target of the two ; and, while her heavy guns are merely breech-loaders, the heavy guns of the Buenos Aires—practically weapons developing equal muzzle energy—are quick-firers ; so that, although speed has obviously been sacrificed in the case of the British vessel, it is hard to see that there is even the appearance of any compensating gain.

This question of speed is one which must now rapidly rise into great prominence. It is the subject, I believe, which first demands the attention of him who, knowing the value of sea power, would study its scientific application under modern conditions.

NATIONAL INFLUENCE AND THE ISTHMIAN CANAL.

By Lewis M. Haupt.

“**A**MERICA for Americans.” This aphorism is the embodiment of the Monroe doctrine, which is construed by some to mean that continental aggressions should be restricted to the eastern hemisphere. Unfortunately, not a few American citizens place a much narrower construction upon the edict, and appear to think that it requires the United States to restrict her operations to her own national domain, to live within herself, to take no part or lot in the affairs of other nations or powers, but so to adjust her policy as to produce what she consumes and consume what she produces,—in short, to build a wall of circumvallation about her, like that ancient structure which once separated China from the rest of the world, and live within herself.

We cannot ostracise our nation, however, without denying to it the functions for which it was created and the high duties and purposes of enlightened Statehood and international comity. The civilizing influences of the Christian nations of the earth cannot be restricted by geographical limits. They are rapidly penetrating the heart of Africa and sweeping through central Asia on bands of steel, while the Star of Empire is rolling westward with giant strides to awaken the occult and populous dynasties of the orient to a new and more vigorous life.

While the massacre of the Armenian Christians excited the sympathy and surprise of America, the eastern question was so complicated (especially in its financial relations) that no one of the powers seemed willing or able, in the interests of humanity, to intervene. With the massacre of the reconcentrados in Cuba and the protracted efforts of these long-suffering people of the Cis-Atlantic to free themselves from oppression, the case was different, and a climax was reached when the innocent officers and crew of the *Maine* were sacrificed in a port supposed to be friendly. Was this an accident? Was it accidental that, while all eyes were focussed on Cuba and the preparations for her deliverance, the reverberations of our Pacific squadron from Asiatic waters suddenly revealed that the Philippine

Islands were in our possession without the loss of an American? Why was the Oregon ordered to make a perilous voyage of nearly fifteen thousand miles to reach a point only three thousand miles from her station, at the risk of being unable to secure coal *en route*, or of being destroyed by Spanish sympathizers in a neutral port, or captured by a detachment from the enemy's fleet off the coast of Brazil, not to mention the great physical stress to the seamen subject to climatic changes, ranging from Arctic cold to tropic heat? Was this great object lesson an accident? Nearly all of these perils, it should be noted, are incidental to the circumnavigation of South America. The sailing course round Cape St. Roque lies nearer to the coasts of Africa and southern Europe than to that of the United States, since the entire continent of South America lies east of the meridian of Florida. Pernambuco, Brazil, is five hundred miles nearer to Cadiz than it is to New York. So is San Francisco, by water. Is it unpatriotic to wish it otherwise? If it were a physical possibility to transport the commerce of the west coast of the United States and place it ten thousand miles nearer, by water, to the eastern and Gulf coast, for a small consideration, would it not be a national disgrace if we failed to utilize so vast an economy? Yet this would be the practical effect of opening a canal across the isthmus. Can any one doubt its utility?

The chief element in effecting the rapid transformation of the peoples of the earth, thus briefly referred to, is transportation. Between continents the waterway is already prepared and maintained; it is necessary only to provide the vessels and open the ports.

For international commerce, that nation has the supremacy which has the cheapest and best system of ocean transportation, and which can utilize her movable plant to greatest advantage. This necessarily involves economic speed, short runs, dispatch in handling cargoes, cheap and durable construction, and economic management, most of which factors are functions of the time required to make a round trip. If, therefore, any time can be saved, without increasing cost, there will result a corresponding economy, and the best way to save time is to shorten distance. Thus the old expedient of cutting artificial channels through obstructing peninsulas has long been recognized as justifiable and desirable; yet there is one section of the earth where such a highway of commerce, although sought for nearly four centuries, is not yet an accomplished fact,—namely, the Isthmus of Darien.

Probably at no place on the globe would the economy in distance be so great as here, and certainly nowhere else has so assiduous search been made for a passage between the two oceans. Nearly all com-

mercial nations have sent out expeditions to discover the "Secrets of the Straits," believed to exist between the Atlantic and Pacific. It was the dream and hope of Columbus, in 1502; of Pinzon, in 1510; of Balboa, in 1513; of Davila, in 1522; of Verrazano and Cortez, in 1523; of de Cordova (who took possession of the outlet of the San Juan del Nicaragua), in 1524; and of Gomez, in 1525. But they were doomed to disappointment.

Antonio Galvao explored the river leading from the great lake of Nicaragua in 1529, and about 1536 Antonelli followed in his footsteps, but during the reign of Philip II—1527-1598—little was done by Spain, as his majesty is quoted as having said that the Lord had placed the Cordilleras across the isthmus as an evidence that they were not to be pierced.

In 1698 the broad-minded Scotchman, Wm. Patterson, attempted to establish a colony, but was driven out; again, Lord Nelson penetrated to Viejo Castillo in 1779, but was obliged to abandon his efforts. Yet these failures did not deter others, among whom may be mentioned Baron Von Humboldt, Gov. de Witt Clinton, Commodore Vanderbilt, Childs, Trautwine, Kennish, Strain, Michler, Shufeldt, Selfridge, Lull, Heuer, Mitchell, McFarland, Menocal, Wise, Eads, Peary, Davis, Dutton, and Ludlow. Many of these were carefully-conducted scientific expeditions resulting in the accumulation of considerable data; some were merely reconnaissances; but they all contributed to throw light on the feasibility of the problem, which is now generally admitted, and to narrow the practicable routes down to possibly two, which it is not the intention of the writer to discuss at this time.

The feasibility of the canal being admitted, its construction becomes a question of *expediency*, and this involves other broad considerations.

The first is that of economy; a second, that of policy or diplomacy; a third, that of ability; a fourth, that of cost. Most of these have been so ably considered by Prof. Keasby in his work on "The Nicaragua Canal and the Monroe Doctrine" that it must suffice to refer to his presentation for specific statements of both history and fact.

As to the general economy of this work, it is difficult to form an estimate in dollars and cents, yet a good approximation to it may be derived from the preliminary basis prepared by Mr. F. W. Kelly, of New York, from the official returns for 1857, given in a report of Rear Admiral Davis, dated July 11, 1866*, from which the following extract is taken.

* See Ex. Doc. No. 62, 39th Congress, 1st Session (Senate).

Table showing the total tonnage that would pass yearly through the isthmus canal, if now finished.

I

	Tons.
United States	1,857,485
England	1,029,295
France	162,735
Other countries	44,555
Total	3,094,070

II

Table showing the value of the tonnage and trade of the

United States	\$193,168,937
England	190,649,584
France	67,210,609
Other countries	16,802,000
Total trade affected by the canal	467,831,130

III

Table showing the saving in money to the trade of the United States that would result from the use of the isthmus canal; according to the official statistics for 1857.

Insurance on vessels and cargoes saved	\$3,863,378-2%
Interest saved on cargoes	3,008,840-1.5%
Saving of wear and tear of ships, 5%	4,643,712-2.4%
Saving of freight money (by time)	11,250,000-5.8%
Saving of wages, provisions, crew, etc.	13,230,000-6.8%

Total yearly saving to the United States 35,995,930
Or $18\frac{2}{3}$ per cent. of the trade of the United States, as given in table II.

IV

Table showing the yearly saving in money to the trade of England, as ascertained by the official returns of 1856, if the trade passed through the isthmus canal, instead of round the capes.

Insurance on vessels and cargoes	\$1,906,495-1%
Interest on cargoes	1,858,826-1%
Saving of wear and tear of ships	2,573,237-1.3%
Saving of wages, provisions, etc.	3,611,700-2%

Total yearly saving to England 9,950,348
Being $5\frac{1}{4}$ per cent. of the value of the trade of England.

V

Table showing the saving in money to the trade of France that would result from the use of the isthmus canal, according to the official statistics for 1857.

Insurance on vesels and cargoes	\$753,000-1.1%
Interest saved on cargoes	452,084-0.67%
Saving of wear and tear of ships	325,470-0.5%
Saving of freight money, estimated by time	276,949-0.4%
Saving of wages, provisions, and outfit of ships	376,427-0.56%

Total yearly saving to France 2,189,930-3.3%
Or 3.3 per cent. of the value of the French trade.

This indicates that the greatest benefits would accrue to the commerce of the United States, and that the saving in about three years would probably equal the cost of the canal.

Table showing the *saving* to the trade of the world by using the isthmus canal.

United States	\$35,995,930
England	9,950,348
France	2,183,930
Other countries*	1,400,000
Total	49,530,208

"Exports of Great Britain increased one hundred and seven per cent. in ten years. Exports of France increased one hundred and thirty per cent. in ten years. Exports of the United States increased ninety three per cent. in ten years. If the trade increases one hundred per cent. in the next ten years, the saving to the world will then be \$99,060,416 per annum."

It will be seen from these statistics that none of the Asiatic or Australian trade, developed in recent years, is included in the above estimates, yet this would properly form a large part of the tributary traffic. But the most suggestive conclusion to be drawn from these figures is the supreme importance of creating such a waterway to prevent the enormous waste inflicted upon the commerce of the world by its non-existence.

For, if, as is stated, the trade increases in value at the rate of one hundred per cent. in ten years, or ten per cent. per annum, and the saving to the trade follows the same law, then it must result that, in the forty years which have elapsed since 1857, when the saving was \$50,000,000 in round numbers, the percentage of increase will be

* Equated from the trade of England, France, and the United States.

four hundred, and that the waste due to the non-existence of this canal would now amount to \$200,000,000 per annum,* or more than double the total estimated cost as determined by the board of experts of May 9, 1889 (\$88,000,000); so that, while valuable time is being consumed in attempting to determine the probable, actual cost within narrow limits, the commerce of the world is subjected to a loss of many times the total cost of the canal, whatsoever it may be found to be, which loss is a tax upon all nations, but chiefly upon ourselves.

While it may not be probable, since the opening of the Suez canal in 1870, that so large a percentage will use the Darien route, yet the experience at the Sault Ste. Marie Canal serves to impress the belief that it cannot be far from the truth; for, after the first enlargement of this canal in 1870, the registered tonnage increased 3.6 times in twelve years. The canal was deepened in 1883 to a 16-foot draught, and, in consequence, the traffic doubled in three years; it doubled again in four years, and it was again more than doubled last year, as a result of the increased facilities provided by the enlarged "Poe" locks, opened August 3, 1896. The reported traffic for 1897 reached the astonishing aggregate of 18,954,000 tons, being an increase of 11 per cent. over the previous year, while the average ton-mile charge was only .83 of a mill. The freight receipts earned by this traffic aggregated more than \$13,000,000 for the year.

This means that, in the brief period of sixteen years, the traffic has increased 1,109 per cent., which is far in excess of the estimate of Mr. Kelly, and illustrates the importance of a broad-minded consideration of these economic questions of transportation by water.

Of this experience the late Col. Poe, United States Corps of Engineers, very pertinently said: "For thirty-five years I have watched the increase of the great lakes commerce, but neither I nor anyone else has been able to expand in ideas at the same rate. The wildest expectations of one year seem absurdly tame by the side of the actual facts of the next."

The figures presented are, therefore, very suggestive and serve to give an idea of the enormous tax placed upon commerce by the failure to open this waterway.

With so great economy to result from the construction of a trans-isthmian canal, the question may well be asked: Why then has it not been completed long ere this?

* From the Report of "Commerce and Navigation of the United States" for 1897 it is found that the total value of the trade for that year aggregated \$1,814,000,000; so that the increase in value in the past forty years would be \$1,621,000,000, or about 840 per cent., instead of 400, as estimated on the basis of Admiral Davis's report. At this rate the economy per annum would reach \$420,000,000, if the canal were opened. Should this great waste be longer continued?

The answer must be found in the history of all great undertakings. First, it required some centuries of exploration to ascertain the proper route; second, when discovered, the problem seemed to be beyond the mechanical and financial resources of the times; third, as it was developed, expanded, and adapted to the increasing demands of commerce, additional obstacles and difficulties were presented, of a complicated nature, but having little to do with the physics of the problem, as follows:

All great and valuable concessions excite the cupidity of mankind, while vested interests fear a division of profits and diversion of business by competing routes. It consequently happens that the most powerful interests which might be expected to be allied against it for self-preservation would be the Panama Canal, the Tehuantepec Ship Railway, the Southern Pacific Railroad, and the Suez Canal. This seems to have been the case; but a broader consideration of the general effects resulting from the construction of such works should soon dispel all fears, leaving no doubt in the minds of the owners of these several properties, or interests, that only good can result to them from this canal. Were there space, this matter of the beneficial effects of deep waterways on competing railroad lines could be abundantly established, but we must be content with a mere reference to a few brief papers on this important law of development, expressed in the aphorism, "*Facilities create traffic.*" *

Notwithstanding the very low charges for through freights by rail, there are many kinds of basic materials necessary to encourage industries which cannot bear the charge, and are either carried by ships around the Horn, at a cost one-seventh that by rail, or are left dormant in the earth. As the average ton-mile rate by rail is .85 of a cent, this for 3,000 miles makes a charge for transportation alone of \$25.50 per ton, which is much more than many such products are worth, leaving nothing for mining, hauling, storage, and other expenses; whereas a charge of, say, \$3.50 per ton *via* "the Horn"

* See Address of O. B. Potter before N. Y. State Canal Convention, 1892.

" " " S. C. Thompson, Proceedings Deepwaterway Convention, 1895.

" " " L. E. Cooley, " " "

" " " L. M. Haupt, " " "

" ENGINEERING MAGAZINE, April, 1892, etc.

The president of the New York Central and Hudson River Railroad, Mr. Chauncey M. Depew writes: "I have always thought the existence of the Erie canal a benefit to the New York Central Railroad, and have therefore favored every movement which liberalized its management or promoted its interests."

And the president of the Chesapeake & Ohio Railway Company, Mr. Ingalls, also takes an advanced position on this question, going so far as to say: "Improvement of the waterways always helps the railways, for the development of the waterways makes business, and the railways then get the higher class freight."

The improvement of the Great Kanawha has greatly increased the tonnage of the railroads skirting its banks.

gives to many products a commercial value they could not otherwise obtain, and renders them marketable. The isthmian canal would still further enlarge the range of materials available for manufactures, and increase the movement in products carried by rail at higher rates, leaving a much greater margin of profit, and thus enabling us to compete more successfully in the markets of the world.

It should be observed also that the actual rate per ton-mile is but one-tenth as much by the lakes as by rail, so that freight may be carried ten times as far at the same cost, or, for an equal length of haul, ninety per cent. of the charge may be saved. Thus the great difference in relative rates would extend the market range one hundred fold (as the square of the distance), which constitutes another impressive reason for the early construction of this highway of commerce.

The prestige of maritime nations, in peace as well as in war, depends upon their sea power, and that is in turn dependent on commercial outposts, refuges, and coaling stations, of which as yet we have practically none; hence we are dependent upon our commercial allies for all such service. The necessity for such outposts is now being impressively demonstrated, and should leave no doubt as to the importance of opening the canal and accepting the overtures of Hawaii for annexation, since it occupies a strategic position in the Pacific.

There are many other cogent reasons why a canal traversing the American isthmus should be built and operated by the United States, but the foregoing must suffice to show that it is a national, if not an international, duty for the United States to construct and maintain the canal. It seems to be her manifest destiny, forcibly impressed by existing conditions, to open a highway for civilization to the east, to enable her to control and defend her commerce and territory on the Pacific and Alaskan coasts, and to bring them nearer to her own base of operation than to the bases of operation of either Europe, Asia, or Africa.

This waterway would save greater distance in proportion to its length than any existing or possible canal on the globe. It is admitted to be feasible; it is shown to be expedient and enormously economical; and it is believed that, instead of being injurious, it will prove beneficial to all existing routes of transportation.

Its most determined opponents are jealousy and avarice, and not until they are overwhelmed by piety and patriotism may it expect deliverance from its enemies. Then, the pen of the president, like the rod of Moses, will be stretched out, "and an highway shall be there, and a way * * * and wayfaring men, though fools, shall not err therein."

SOME FEATURES OF INDIAN RAILWAYS.

By J. W. Parry.

THE unique position attained by the Indian railways as successful pecuniary undertakings and safe investments of a superior class is beginning to attract the notice of capitalists and financiers. For we find that, while English and American railways pay $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. dividends, and the Australian system is worked at a loss, the Indian lines earn 4 to 9 per cent. on the subscribed capital. The average return, even in this famine year, when trade was disorganised, is given as 5.2 per cent. for all the railways taken together, while it is fully anticipated that the average for the financial year ending March 31 next will be $5\frac{3}{4}$ per cent. The share value of every Indian railway quoted on the Stock Exchange is at a premium. Can this be said of the railways of any other country?

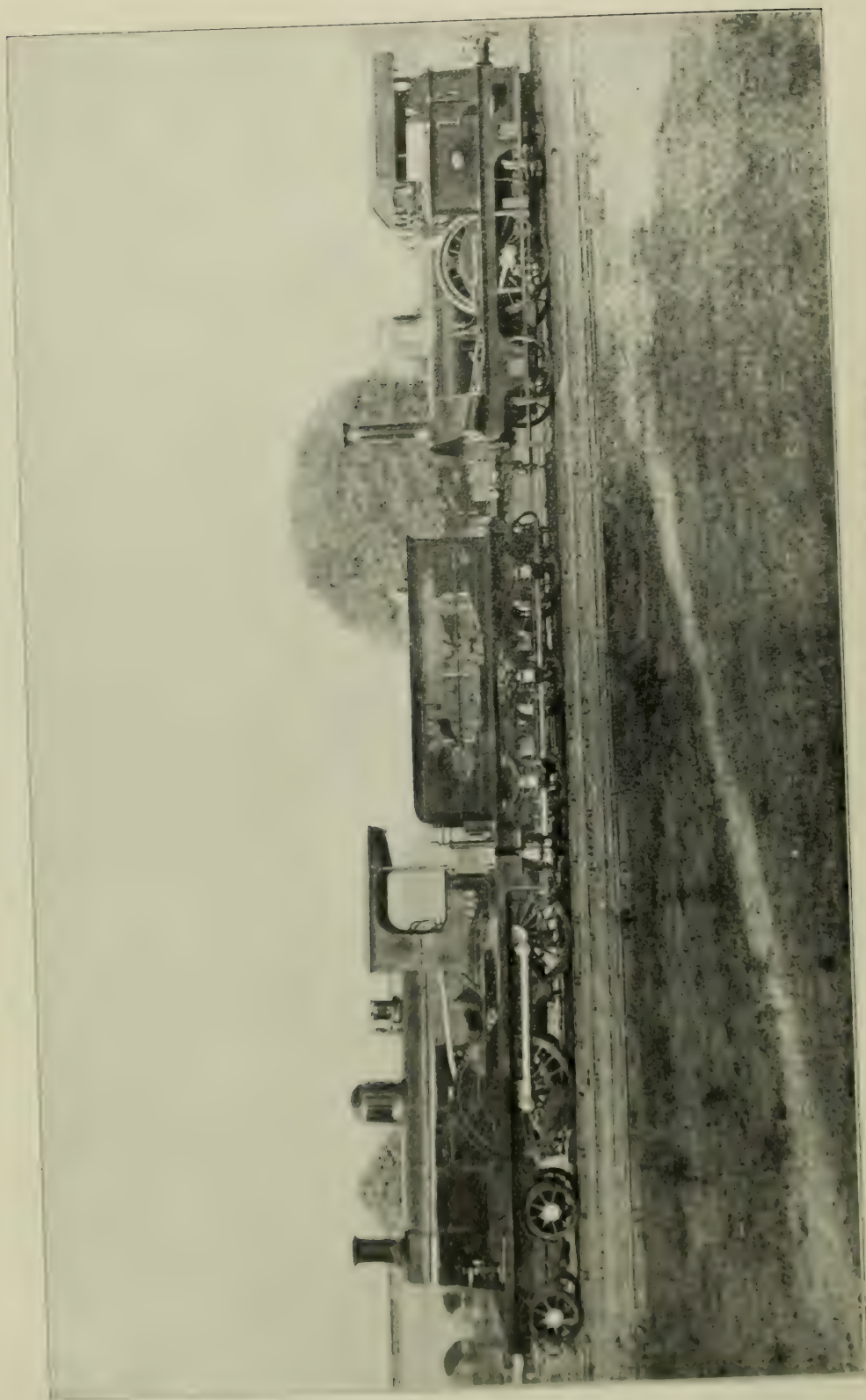
Just two years ago the Rothschilds took over the Burma system of railways from the secretary of State for India, on what were considered hard terms,—namely, a guarantee of $2\frac{3}{4}$ per cent. plus half profits for 21 years. Burma is a country likely to develop rapidly, and the Rothschilds are not men to accept such terms unless they feel confident either that the investment will be immediately profitable or that it has possibilities for the future not easily to be found in home and foreign markets. The question then arises: What is the cause of the success of Indian railways? Are the lines run up anyhow? Are they jerry-built? or does India possess some inherent advantage over England and America? Before replying to these questions, I will try to remove certain erroneous opinions held even by experts who pose as authorities on Indian railways because they have made a six months' cold-weather trip to the gorgeous east.

In the first place, then, it is necessary to state that the main arterial lines constructed in the early days—namely, the East Indian, Great Indian Peninsula, Madras, and Bombay-Baroda systems—were by no means as cheaply built as some suppose. Each of these systems cost more than two lakhs of rupees per mile when the rupee was more than two shillings in value,—in other words, more than £20,000 per mile. Yet two of these systems—the East Indian and Bombay-Baroda—in ordinary years earn 7 to 9 per cent. on the subscribed capital in rupees, while the Great Indian Peninsula, with its heavy gradients works crossing the Western Ghâts in two directions, Jabalpur and Raichore, and the Madras Railway, in which the serious error was made of avoiding the large towns to prevent detours, manage to

earn $4\frac{1}{2}$ to 6 per cent. when the traffic is normal and a higher rate when the harvests are plentiful. Within the last 20 years Indian engineers have learned to build railways at considerably reduced rates, although the rupee has fallen in value and labour has risen in price 50 per cent., chiefly due to extended experience and keen competition. For we find in the Blue Books that the present Indian broad-gauge lines cost from £8,000 to £10,000 per mile, and the narrow-gauge lines from £6,000 to £7,500 per mile, exclusive of rolling stock, in ordinary country, and somewhat more in hilly country.

In the next place, the idea that the high percentage or good dividend earned is squeezed out by providing poor accommodation for all classes of passengers is a delusion. The third-class carriages on Indian railways are no whit inferior to those on the English suburban lines, such as the L. B. S. C. R. or L. C. D. R., or to those on the French railways, in which there are no cushions to the seats or back and no bunks for sleeping. The first-class and second-class carriages on Indian railways, though not so handsomely upholstered or elaborately fitted up as those on the "heavy" English lines, are quite equal to the carriages of the above-mentioned companies. The seats always have cushions, and each passenger can have a berth or bunk for sleeping during the night. Lavatory arrangements with conveniences are invariably provided for the upper classes, and are also being gradually introduced on the third-class carriages. When, however, one reflects that the first-class fare in India is only slightly higher than the third-class in England,—namely, $1\frac{1}{4}d.$ per mile,—while the third-class in India varies from $\frac{3}{8}d.$ to $\frac{1}{2}d.$ per mile, it must be admitted that passengers are most unreasonable if they complain that their comforts are not being duly attended to, or if they expect panelled photographs to while away the tedium of a long journey. Even these luxuries, however, may come in time. Surely cane-bottomed seats without cushions during the day are cooler and more comfortable in the warm season.

There is one point to which attention might be drawn here,—namely, that during festivals (*melas*) and pilgrimages third-class passengers often have to be transported in low-sided wagons with a tarpaulin or corrugated iron roof over their heads, herded like cattle, because none of the railways have sufficient rolling stock to cope with extraordinary rushes of traffic. To counterbalance these inconveniences the fares are further reduced, to say, one farthing, or even less, per mile. The modern pilgrim travels with far greater comfort and at far less expense than his fathers did before him; in fact, a pilgrimage in these days is reduced to a pleasant outing or a picnic, instead of being a severe penance.



TYPES OF LOCOMOTIVES, 1854-1897. EAST INDIAN RAILWAY.
By permission of Indian and Eastern Engineer.



BORI BANDAR STATION, BOMBAY.

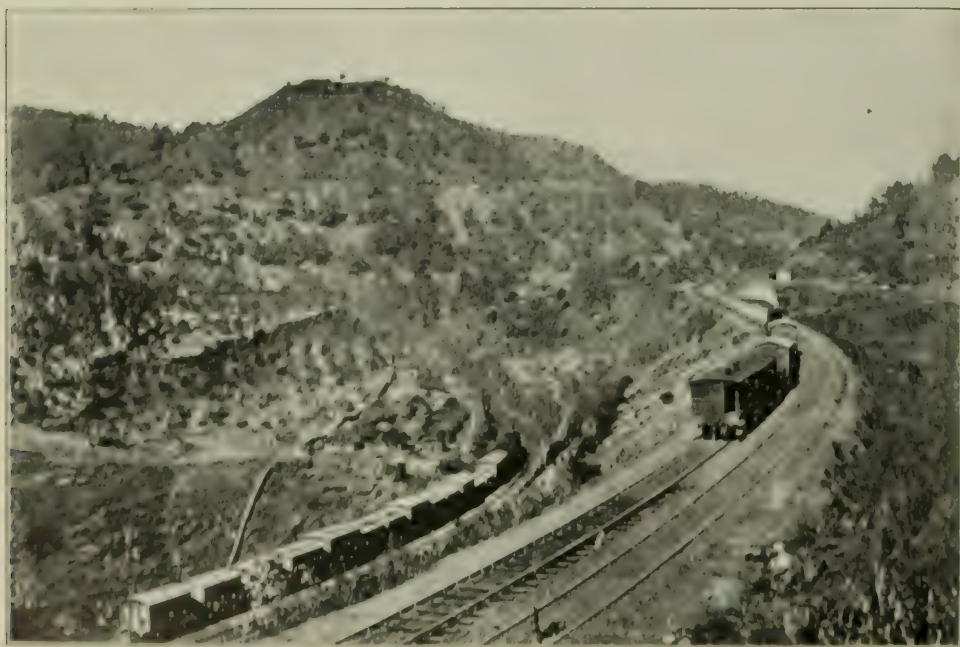
The Victoria Terminus of the Great Indian Peninsular Railway.

In the building of Indian railways the specifications seem to have been more rigidly adhered to than is usual in England. The writer has observed, in the building of railway bridges and stations in the suburbs of London and elsewhere, the use of a quality of bricks and lime which would not have been permitted in similar works in India. If such materials had been put in during the absence of the assistant or executive engineer, the structures would have been condemned and pulled down by order of the chief engineer or the government inspector, and the subordinate, or clerk of works, and engineer-in-charge, would have been severely reprimanded for neglect of duty.

The procedure adopted in the construction, maintenance, and management of Indian railways, though modelled after English practices, differs in many details from the practice usually adopted in western countries where labour has a high value. For example, earth work is done by baskets, trucks and wagons only occasionally being employed, and the banks being made from side trenches or borrow pits, while the stuff from cuttings is bad for one hundred yards and the remainder thrown to form spoil banks. In brick work or masonry the practice is much the same, curved-wing walls being seldom used. In roofing buildings many different methods are employed, according to the cus-

toms of the country. Thus there is the Sind roofing, made without scantlings, of hollow, slightly-tapered hexagonal tiles eight inches in length, and there are hemispherical domes on the Rajputana-Malwa Railway, formed of concentric rings in horizontal courses and built without any scaffolding. But the most usual roof is the flat or terraced one, of mud or fine concrete on battens and boarding, or on corrugated iron sheets. Here mention might be made of small staff quarters being roofed by hollow earthenware water pots, called "gharas," supported on old bull-headed rails in imitation of similar structures used by the Romans, of which ruins may be seen in the vicinity of Rome. Again, because of the military occupation of the country, certain peculiar features are found toward the northwest and northeast frontiers; thus the Lahore railway station has circular turrets, loopholed to protect the besieged. The tunnels on the Muckaf Bolum and the Sind-Pishin are crenelated with machicolations, so that they may be defended against the attacks of an enemy. Lastly, in all the large Punjab bridges the abutment is made extra wide, and within the space so formed is provided a well-hole with a pump, so that the defenders may not be starved out and need not expose themselves when getting water during a state of siege.

We may now enquire into the causes of the success of Indian railways, making them a model for the whole world to copy. It may be alleged that the African railways pay 8 per cent. ; true, but only



REVERSING STATION, BHORE GHAT.

Great Indian Peninsular Railway.



PORTION OF KISTNA BRIDGE, BEZWADA (MADRAS).

2,200 miles are opened for traffic, while India has ten times that length open. Long before Africa has 20,000 miles open, the directors will find that so high dividends cannot be paid regularly.

That low rates stimulate traffic is a fact that was not known in England and America until keen competition with foreign produce made it evident; but it was foreseen by Indian administrators and engineers. India is a poor country, and it was clearly understood that, unless goods and passengers could be carried at abnormally low rates, compared to those in England, there would be no traffic of any kind. To show how alive the native merchants are to cost of carriage, it may be stated that the Madras railway yearly loses the carriage of many thousands of tons of grain because the alignment has not followed the usual trade routes and the stations are not conveniently near the towns. Another case, which came under the writer's notice so recently as 1888, while he was resident engineer, may be mentioned. Leiah and Multan are two large grain centres, being joined by a road crossing the deserts of Sind-Sagar. The railway makes a slight detour to get a good crossing of the Chenab river. While this large bridge was being built, the railway was open to traffic, but the traders were charged a small ferry fee, with the result that the road was util-



CANAL VIEW, BEZWADA (MADRAS).

ised in preference to the railway. Immediately the ferry fee was removed, the grain traffic came back to the railway.

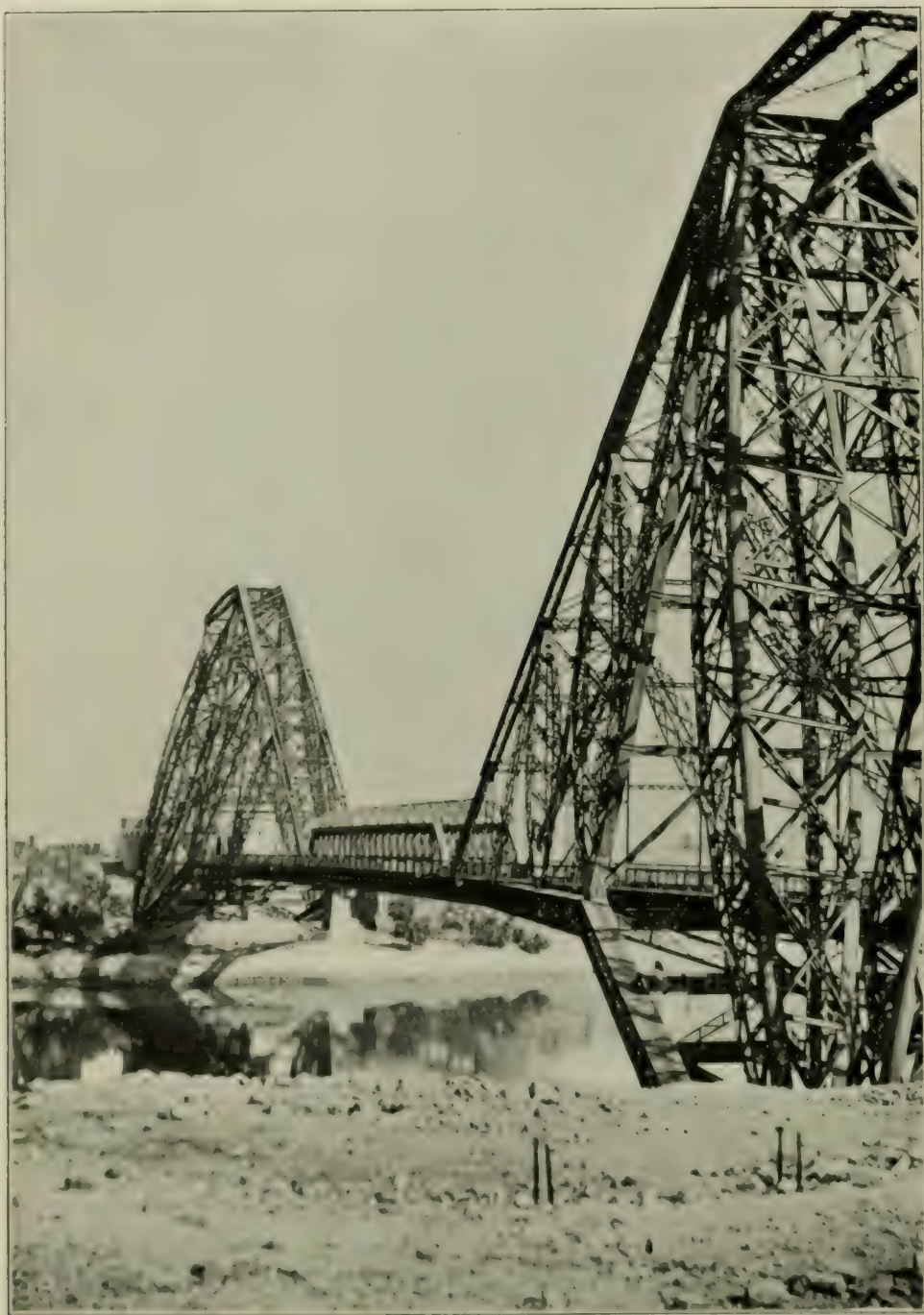
As a proof that even experienced men may be mistaken or take too pessimistic a view, it may be stated that in 1880, when the Rajputana-Malwa railway was opened, it was believed that one goods train and one mixed train each way would be sufficient for all purposes. Strange to say, from the commencement six trains each way were required; then nine; and so on, until as many as forty trains were run on this single track. Even now the stations and goods sheds are often choked with grain bags. The Rajputana-Malwa belongs to the Bombay-Baroda system, but the accounts are kept separately, and the returns show that 9 to 11 per cent. on the subscribed capital are the usual earnings. The writer feels a natural pride when he remembers that he was one of the engineers on two different sections, even though his life was threatened while he was engaged in the Serohi district.

There are five classes of goods, the lowest rates being charged for class 1. These rates vary from $\frac{1}{10}$ to $\frac{1}{5}$ of a pie per mile per maund ($82\frac{2}{7}$ pounds) or 4 to 27 pies per ton-mile. It is not easy to calculate the equivalent in English currency, as the rupee varies daily, but roughly speaking, the rates vary from $\frac{1}{3}$ d. to $2\frac{1}{4}$ d. per ton-mile,—no doubt considerably less than railway, or even canal, rates in England. In the latest Blue Book the principal commodities and the earnings therefrom on the standard and metre gauge lines for 1896 are given as follows:

Commodity.	Tons.	Earnings Rs value.
Grain and pulse.....	5,701,249	30,186,439
Coal and coke.....	4,505,758	13,498,668
Oil seeds.....	1,701,577	11,095,251
Salt.....	1,471,713	8,451,630
Jute.....	1,200,312	6,373,532
Sugar.....	1,161,703	7,602,137
Other articles of merchandise.....	1,978,171	12,386,668

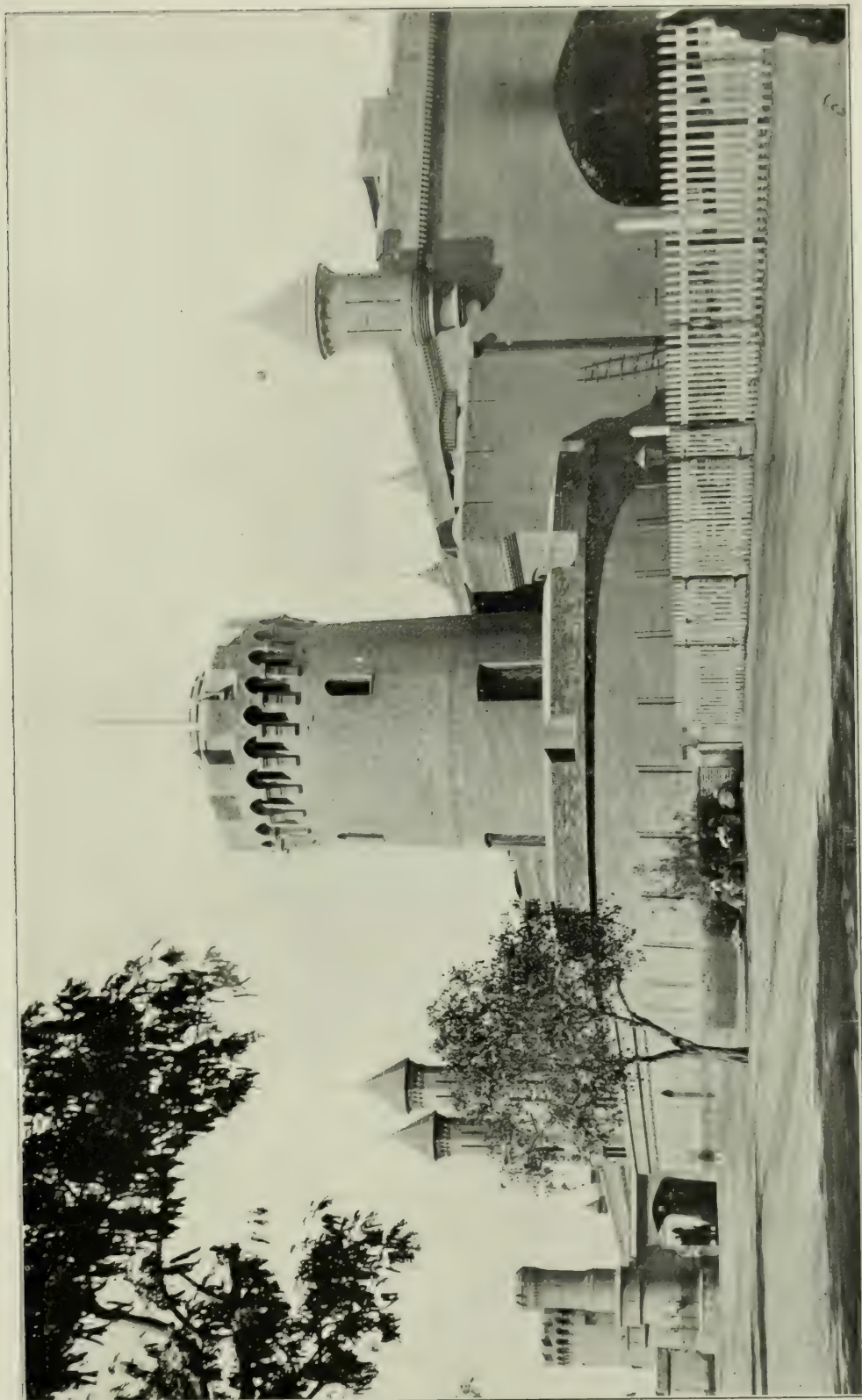
Besides these, there are cotton (raw and manufactured), metals, provisions, railway plant and rolling stock, timber, wool (raw and manufactured), liquors, drugs and chemicals, tobacco, paper, silk, and many other items. In every case the earnings of 1896 were less than those of 1895. Those of 1897 should show an increase, then, over those of 1896, and perhaps over those of 1895 also.

One of the most important factors in, if not *the* principal cause of, the financial success of Indian railways is no doubt the low rates at which land has been acquired. In some instances wealthy land-owners have given the land free to the paramount power, having their



ONE SPAN OF THE SUKKUR BRIDGE.
North Western Railway.

names published in the *Gazette* of India as public benefactors. In other cases waste lands have been obtained at merely nominal rates. In no case, I believe, has even irrigated land in the districts been assessed at a higher value than £50 an acre, and most of the land has

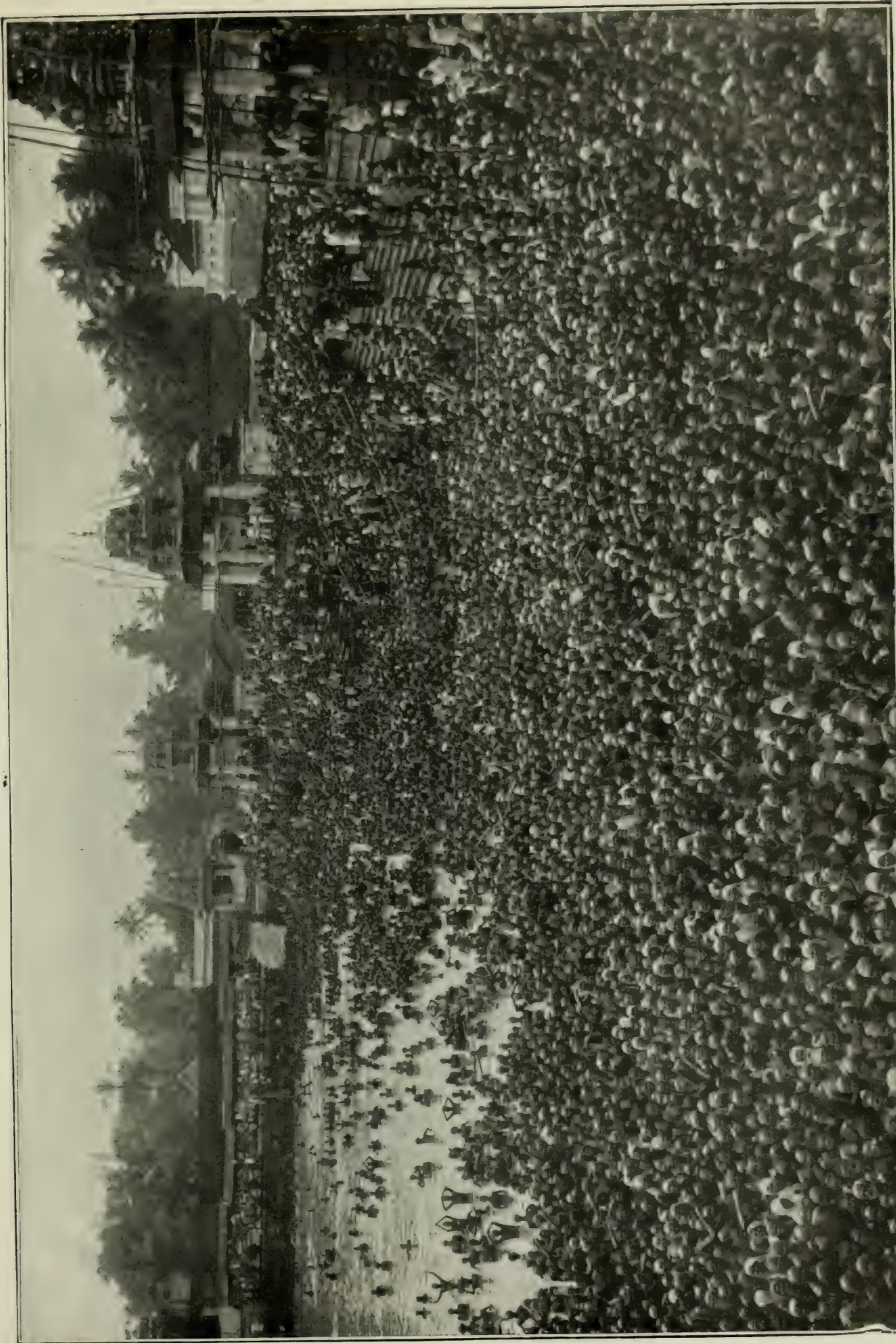


LAHORE STATION, NORTH WESTERN RAILWAY.
Showing turrets and loopholes.



TUNNEL NO. 3, HOLKAR STATE RAILWAY.
View of Down Face, Showing Deep Cutting.

been paid for at rates running from £10 to £40 per acre. It is possible that near the Presidency towns a few acres were paid for at higher rates, say, even £200 per acre. When, however, one compares the above rates with the prices paid in England and America, one cannot be surprised that English railways are over-capitalized to the tune, it is said, of fifty millions sterling. Another factor of no mean importance is that no money has been wasted in exploiting schemes, paying concessions, or contesting rival plans before parlia





GADARIA VIADUCT, B. S. RAILWAY.

mentary committees, all of which processes run away with immense sums of money. The government of India orders a survey to be made, and the matter is gazetted, so that all concerned may know; the survey is, as a rule, carried out, without molestation of any kind, by a regular staff. If funds can be allotted, a special land commissioner is appointed to take over the land, the engineers meanwhile entering on the land and commencing operations. Take the case of the Rewari-Ferozpur line, 90 miles in length from Rewari to Hissar. This was surveyed by two parties from March to May, 1881. The estimates and plans were prepared, and construction commenced in October, 1881, the line being opened for traffic in June, 1883,—within two years from the time the first orders were issued. The country traversed was easy; still, in what other civilized and populous country could ninety miles of railroad be surveyed and constructed in two years? The prairies of Central America cannot be compared, for here were no vested interests, few settlements or claimants, and probably no rivers or difficulties of any kind.

Another important cause of the cheaper construction of Indian railways is the cheapness of Indian labour. In Burma and Baluchistan unskilled labour gets one shilling a day, and skilled labour half-a-crown, while in most parts of India ordinary labourers get sixpence, and excellent masons and carpenters can be obtained for eighteen pence, a day. There are no trade unions in India; still, strikes are by no means uncommon, as every engineer knows. If the contractor will not pay his labour regularly, they refuse to come to work, and the engineer has to act the part of the board of trade and put in force an act of conciliation, though the particular act was never passed by parliament. During harvest time labour often cannot be obtained for love or money, while religious festivals and marriage ceremonies frequently draw away men at most inopportune moments. The English labourer is troublesome in his way, but the English contractor has not to contend against superstition of a most ghastly kind. Suppose a bridge is being constructed over a sacred river, and an accident occurs; nothing will induce the gangs to resume work till goats, kids, calves, or other sacrifices have been made, and it is generally rumoured that, to propitiate the deity, a few virgins should be immolated. This is no sentimental story; such a thing has occurred within the experience of many engineers.

Every country has to acquire its experience in methods of doing work. We have seen that no money was wasted in acquiring land or fighting rival schemes; yet time and money have been wasted in other ways. During 1871-1874 it was found that the standard gauge from Lahore to Kurachi was costing too much, and it was proposed

to introduce the narrow gauge between Multan and Kotei, thus making two breaks in gauge in about 850 miles. This "battle of the gauges" was fought out at the Institution of Civil Engineers, and, through the influence of that body with the marquis of Salisbury, the attempt at cheapness was frustrated; otherwise the development of the port of Kurachi would have been delayed many years.

There is another cause which helps to swell earnings,—the pilgrim traffic. If the crop is a bumper one, the grain comes in so rapidly that the stations and goods sheds are blocked with bags of grain, especially during March and April. Before the grain has been completely cleared, the pilgrim traffic begins,—in May, just after the harvest has been gathered; the cultivators then feel that they have earned a holiday till June 15, when the rains may be expected. This pilgrim traffic is getting heavier every year, for more people travel now than ever before. Notwithstanding the famine, 7,750,000 more passengers were booked during 1896 than in 1895, though the tonnage of goods was slightly less than before. As in all countries, so in India, the railways suffer from slack periods, when the rolling stock suffices; but, as a rule, there is complaint that in busy periods the Indian railways are very deficient in rolling stock.

The following are some of the projects which are at present attracting the attention of professional men and merchants. (A) The Visagapatam-Raipur railway, to connect the port of Visagapatam with Raipur in the central provinces. This route was surveyed fifteen years ago, and is being commenced as a famine work, but will open immense tracts of country, some fertile, some waste with minerals. (B) The Calcutta-Karachi through route across India. *Indian Engineering* says: "Marover junction to Kotah and Goona to Jhansi are not in the schedule of lines under survey or projected, but it is to be hoped that they will be included in this year's programme. The line from Shadipalli to Balotra, now in progress, completes the chain." (C) The development of the Damuda Valley coal-fields, which have been unnecessarily delayed, simply because the country to be traversed is somewhat difficult. The problem of the future supply of fuel for locomotives has long exercised the minds of engineers; yet sanction cannot be obtained for this important scheme. (D) The Delhi-Kotri line through the deserts of Bi kanir. The chief difficulties to overcome are sand ridges three hundred feet in height, and want of water; but, if land is to be found for India's teeming millions, this problem must be attacked. Reconnaissances and levels are available. (E) The Benares Puri scheme, surveyed some twelve years ago and then dropped. Any company taking up this scheme will find it a remunerative one, as it joins two places of pilgrimages containing holy

shrines. (F) The through connection between Burma and Assam. Three routes have been surveyed by Mr. R. A. Way, chief engineer, who suggests the most northern one ; but the project hangs fire from lack of funds.

In addition to the above there are at least one hundred and fifty projects available in the public works secretariat of the government of India. In April, 1895, the writer read a paper before the Society of Arts on "The Coming Railways of India and Their Prospects." The majority of the railway projects he then suggested have either been taken up already, or are being proposed.

The Indian railways are classified into five divisions: (1) State lines worked by companies; (2) State lines worked by the State; (3) lines worked by guaranteed companies; (4) lines owned by native States and worked by a company; (5) assisted companies. One should always bear in mind that, on account of the military tenure of the country, there are also two great classes,—namely, military lines, built almost exclusively for the defences of the empire, which are unremunerative, and commercial lines, intended to develop the resources of the country.

Due to financial pressure, wars, and the contrary opinions held by different men in authority, the railway policy of the government of India has been a vacillatory one from the beginning. It is sufficient to point to the latest case. Two years ago a railway programme was drawn up by Lord Elgin, when it was proposed to allot five crores of rupees per annum for five years for the construction of railways alone ; but what do we find? On account of the frontier troubles this allotment has already been halved, and further curtailments no doubt will be shortly ordered. Of course in such a case one cannot blame the government of India. Unfortunately, however, this causes not only waste of time, but—what is worse—a want of confidence in the minds of contractors and others, who are suddenly ordered to stop their works, though they have completed their arrangements for prosecuting them with vigour. The most serious charge, however, levelled against the government of India by the press seems to be this—that, while it professes to encourage private enterprise, every obstacle seems to be placed in the way of those desirous of obtaining concessions. Thus Mr. Calthorpe, in a paper read before the Society of Arts, states that his company offered to construct and maintain the Barsi light railway without a guarantee ; yet it took eight years to obtain the concession, with two special visits to India and an expenditure of three thousand pounds. No doubt there are many applications for concessions, some of them "bogus," so that careful enquiries have to be made and securities exacted that the concession-

aires intend to do the work directly themselves, and will not dispose of their grant to someone else. The British public, or, rather, financiers, have become so accustomed to a guaranteed rate of interest that it is not easy to get even a hearing, unless this condition has been granted. Therefore the government should be more liberal, relaxing the rules when any respectable firm comes forward with a proposal to construct feeders without any guarantee at all.

The government of India is so dreadfully afraid of debt that it desires to build its railways out of surplus revenue. Now, no country in the world ever undertakes productive public works except by borrowed capital; moreover, the debt incurred for railways and canals in India is so small—a few millions—that this debt might easily be doubled without fear of disaster. The great bugbear is, of course, the constantly changing value of the rupee, which has caused the secretary of State for India to resolve that in future all proposals must be in rupee capital,—a thorn in the side of the London money-lender, who prefers his interest in sterling.

In addition to the difference between western and eastern practice in construction, maintenance, and management, there is a remarkable difference in policy. The Indian press is constantly clamouring for encouragement of private enterprise; so the government gave over the East Indian and Rajputana-Malwa railways to be worked by companies,—a singularly weak attempt at economy, as these two are the best paying lines in the whole country. On the other hand, political agitators in England are beginning to clamour for the nationalisation of British railways. This is not likely to take place, as no ministry dare face the expense, but, even if the transfer could be effected, the public would soon regret the bargain, for State management is not nearly as progressive as private enterprise.

DILUTION PROCESS OF SEWAGE DISPOSAL.

By Rudolph Hering.

THE waste water of cities, or what is called sewage, contains ingredients which may become objectionable in two ways.

The most dangerous ingredients are those which can affect the health of human beings. These are the disease-producing bacteria which enter the sewage, for instance, through intestinal discharges or through laundry water, when clothes worn by sick persons have been washed therein. When such bacteria find their way into the air or into drinking water, a propagation of the specific disease is thereby invited.

During the last twenty years bacteriology has shown that many, and probably all, of the so called zymotic diseases are caused by germs which are transported by air or water. It has also been demonstrated that many cases of illness and death can be prevented by a careful and proper disposal of the sewage.

Some of the pathogenic bacteria perish rapidly, after they leave the body and have been taken up by the sewage, but others persist to a remarkable degree. We have evidence that the typhoid bacillus survives after the sewage which contained it has been converted into practically clear water, and even after such water has been frozen for several weeks. We must therefore seek to destroy these pathogenic bacteria, or remove them in as thorough a manner as practicable.

The other way in which sewage becomes objectionable to a community is by its offensiveness. This is produced by the development and diffusion of gases which are the results of a rapid decomposition or putrefaction.

The sewage pollution, dangerous to health can be ascertained by a chemical analysis, by an inspection of the watershed, and principally by a bacterial analysis. The pollution which is objected to merely on account of its offensiveness can be measured by a chemical analysis alone.

In a proper system of sewage disposal, therefore, the main object is to destroy disease bacteria, or at least render them harmless, and the secondary object is to prevent putrefaction or offensiveness.

It is the engineer's duty, when designing the works, to prevent these objectionable results, and to provide satisfactory conditions at the least possible cost.

It was formerly held that the disposal of sewage was really an agricultural question,—that a city's manurial refuse had a high money

value, and that it should be returned to the earth whence it came. In Europe this opinion prevailed for many years, and is still occasionally defended on grounds of political economy. But now another point of view has forced itself into recognition, and has generally carried the day. It brings into the foreground the cost of the method of disposal. If the expense of returning sewage to the soil is greater than that of using other manures of equal value, then sewage utilization, says the modern economist, is no gain to the community. It will be better to let the matter go to waste. Pure gold exists in many of our rivers. But in most cases it would cost more to extract it and render it useful to the community than it is worth. Therefore it is economy to let this precious metal remain where it is.

We can choose between several practical ways of treating sewage, according to the necessities of the case.

If the foul water or sewage of a community is liable to enter a stream whence water is taken for drinking purposes, it is imperative to purify the water or the sewage. Whenever the stream is not subsequently used for a water-supply, such a purification may not be required, and it is necessary simply to prevent a nuisance.

The present article deals with the latter class of cases, where a water-supply cannot be injured by the introduction of sewage into a stream, where it is merely necessary to prevent offensiveness, and where the sewage can be left to gradually and completely disappear in unassisted natural ways.

It is impossible to prevent all disease germs from getting into a water course. We can guard it only against a serious pollution. We cannot prevent rain from washing the streets, the fields, the forests, and discharging this cleansing medium into the streams. And along with this water must go the dust of the air, and the myriads of bacteria sometimes contained in the same. There must go with it parts of the intestinal discharges of animals, birds, and insects, and parts of the manure with which the fields are covered. Unquestionably much injurious matter is carried into the water courses by the rain water, and we cannot prevent it.

We are therefore obliged to seek safety in another direction,—namely, in the filtration or purification of all water-supplies immediately before the water is used. How clearly this conclusion is recognized we can see in some cases in Europe, where, although the water comes from uninhabited mountain districts and is apparently pure, provisions are made for its filtration before it is furnished to the inhabitants for domestic use.

Disposal of the sewage of a city by dilution in a river is still very common, and we are even forced to acknowledge that it will remain

so for a long time. In Europe we find cities situated on some of the larger rivers, discharging their sewage into them with entire impunity, provided certain governmental restrictions are followed. In our country we have cities along the Mississippi, Missouri, Ohio, and Delaware rivers, discharging their sewage into these water courses without causing any offence. Such a disposal attracts unfavorable attention only when the water is subsequently used as a domestic supply.

We find, further, that the cities on our great lakes discharge the sewage into their waters, and dispose of it finally by dilution, while deriving their water from the same lakes. No doubt the question here is likely to become a serious one, and it is highly probable that, in the future, unless the sewage outfalls and water intakes can be kept sufficiently well separated, either a treatment of the sewage before its discharge, or a purification of the water-supply, or perhaps both, will be required.

Various authoritative statements have been made regarding the permissible addition of sewage to streams in order to prevent objectionable conditions. About the year 1867 a statement was made by Dr. Letheby and others in England that, if the sewage is diluted to at least twenty times its volume, it will not only be made inoffensive, but be thoroughly destroyed after flowing a "dozen miles or so." The rivers pollution commission of Great Britain, in 1878, maintained that no river in England was long enough to allow of a complete disappearance of sewage matter discharged into it.

Dr. Fleck (*Ueber Flussverunreinigung. Jahresbericht der Kgl. chem. Centralstelle, Dresden, 1884*), after an extensive inquiry into the subject in Germany, expresses the opinion that water is to be considered objectionable if in 100,000 parts there are contained more than 1 part of organic matter and more than 0.01 part of ammonia.

Some years ago, when engaged in solving the difficulties of sewage disposal for Chicago, the writer found that the problem could be most economically solved by adopting a somewhat unusual plan of sewage disposal. A canal was recommended to be built, leading from Lake Michigan to the Illinois river, a branch of the Mississippi. Into this canal the sewage of Chicago, diluted with a sufficient quantity of water from Lake Michigan, was to be discharged, that it might flow by gravity into the Mississippi river. Incidentally this project had the economical advantage of establishing a water way for large boats between the lakes and the Gulf of Mexico. The project was adopted on these merits, and its execution is now almost complete. An artificial purification of the sewage and a return of the effluent water into Lake Michigan had been found to be more expensive than the proposed scheme, and also less advantageous to the community.

The necessity for constructing an artificial channel of very large size and great length necessitated a most careful inquiry into the proper degree of dilution that should be given to the sewage to make it inoffensive and in all respects unobjectionable in the canal and the rivers of the Mississippi valley. Whatever information could throw light on this subject was collected from Europe and from this country. The conclusion was that a flow of four cubic feet per second should be provided for the sewage of every thousand persons. Since then confirmative information has been collected, and to-day the presentation of the problem of sewage dilution is not beset with as many difficulties as formerly. A safer opinion may be reached regarding necessary conditions.

The first point to settle was the unit of measure of permissible pollution. Inasmuch as the water consumption per head of population varies so greatly in different cities, and as the quantity of water thus used ultimately represents the quantity of sewage, the latter is a very indefinite unit. The writer therefore suggested ("Notes on Pollution of Streams," Vol. XIII of the American Public Health Association, 1888) that the unit be the average pollution caused by one thousand persons. The quantity of refuse per inhabitant does not vary much, and thus the average becomes a satisfactory measure. Where a large amount of industrial refuse is discharged into rivers, a special allowance must, of course, be made therefor.

The second point to settle was the standard of inoffensiveness. As this can be measured only by personal judgment, it cannot be exact. But if the water is to be used for manufacturing purposes, it is possible to be more accurate. As some mills may require a higher standard than others and a particular kind of purity, the effect upon the particular industry may be readily ascertained.

A standard for the prevention of destruction of, or injury to, fish is again more difficult to fix, as it depends on the particular species which it is desired to retain. Some fish and crustacea apparently live and thrive in sewage-polluted water. Others die where there is but a slight pollution. Some fish are killed where the sewage flow is concentrated, but live when the same sewage has been dispersed in the stream. Oysters have been so infected by sewage-polluted salt water as to propagate typhoid fever.

While it is possible thus to throw some light on the requirements for a safe sewage discharge into streams, each case, nevertheless, requires special examination, and no specific rules can be set down which are applicable to all cases.

There are several ways in which we may determine the least number of cubic feet of water required to cause the sewage from one

thousand persons to be inoffensive. In the first place, it is possible to obtain a sample of the sewage in its most concentrated state and mix it with enough water to make it unobjectionable, and thus determine the required dilution. This method is somewhat crude.

Secondly, it is possible to observe the gradual increase of pollution in a water course by successive discharges from a number of sewers, and, after determining the point at which the condition of the river becomes objectionable, to measure the flow of the stream at that point. Then, knowing the number of people whose sewage enters the stream, it is easy to find the desired measure of permissible pollution. Such information is available from a number of cities in Europe and America.

Thirdly, in a comparison with known cases, we may determine the number of people who can use a given stream for sewerage purposes without making it offensive, by the amount of free ammonia brought into the river with the sewage. This method is often the safest one, particularly where a stream is already somewhat polluted before it reaches a town which is to add more sewage to it. The composition of the water of the stream is first ascertained, and then, by calculation, it can be found what number of people will, by their additional sewage, produce the greatest pollution permissible.

The Massachusetts State Board of Health has made some investigations with this method ("The Pollution and Self-Purification of Streams," F. P. Stearns, 1890). By averaging the observations in several cities, it finds that the following standard amounts of each of the constituents contributed daily per inhabitant are required to change water into sewage.

Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
.015 pounds.	.003 pounds.	.218 pounds.	.042 pounds.

With these figures as a basis, the table given on the opposite page was prepared, which substantially accords with the information published by the board. No consideration is given to the analysis of the natural water flowing in the stream.

In using the table, it is generally sufficient to ascertain the free ammonia, which is a characteristic feature of sewage pollution, although by no means an unfailing index of offensiveness, which also other conditions may affect.

From what has been said, and from what will be said further on, it may be seen that a definite answer to the question of permissible pollution must rest upon a special investigation in each case. Nevertheless it is practicable to state certain general limits. In the above table the authorities of the State board of health have drawn two lines between which lies doubtful ground. If the flow of a stream is

CALCULATED COMPOSITION OF SEWAGE OF DIFFERENT DEGREES OF DILUTION IN A RUNNING STREAM.

Flowing Water.		Ammonia.		Dissolved Solids.	Chloride.	Re- marks.
Cubic feet per second per 1000 persons.	Gallons per Capita per day.	Free.	Albumin-oid.			
		(In parts per 100,000.)				
0.062	40	4.50	.90	65.4	12.6	Dilution is offensive.
0.077	50	3.60	.72	52.3	10.1	
0.093	60	3.00	.60	45.3	8.4	
0.108	70	2.57	.52	37.4	7.2	
0.124	80	2.25	.45	32.7	6.3	
0.140	90	2.00	.40	29.1	5.6	
0.155	100	1.80	.36	26.2	5.0	
0.186	120	1.50	.30	21.8	4.2	
0.232	150	1.20	.24	17.4	3.4	
0.310	200	.90	.18	13.1	2.5	
0.388	250	.72	.14	10.5	2.0	
0.465	300	.60	.12	8.7	1.7	
0.5	323	.5580	.1114	8.10	1.56	
1.0	646	.2790	.0557	4.05	.78	
1.5	969	.1860	.0371	2.70	.52	
2.0	1,292	.1395	.0278	2.02	.39	
2.5	1,615	.1116	.0223	1.62	.31	
3.0	1,938	.0930	.0186	1.35	.26	
4.0	2,584	.0697	.0139	1.01	.19	
5.0	3,230	.0558	.0111	0.81	.16	
6.0	3,876	.0465	.0093	0.67	.13	
7.0	5,522	.0399	.0080	0.58	.11	
8.0	5,168	.0349	.0070	0.51	.10	Dilution is not offensive.
9.0	5,814	.0310	.0062	0.45	.09	
10.0	6,463	.0279	.0056	0.40	.08	
15.0	9,694	.0186	.0037	0.27	.05	
20.0	12,926	.0139	.0028	0.20	.04	
30.0	19,389	.0093	.0019	0.13	.03	
40.0	25,852	.0070	.0014	0.10	.02	
50.0	32,315	.0056	.0011	0.08	.02	
100.0	64,630	.0028	.0006	0.04	.01	

less than two and one-half cubic feet per second per thousand persons discharging sewage into the same, an offence is almost sure to arise. When the flow is greater than seven cubic feet per thousand persons, offensive conditions are not likely to result. In other words, when the free ammonia contained in the water is greater than 0.1116, the conditions will probably be objectionable, and, if it is less than 0.0399, it is not likely that the sewage in the water will be noticed.

Within these limits judgment is required in order to select a

proper figure, and in forming judgment several other points should be considered.

The effects of mill-ponds may be serious in a sewage-polluted stream. By the reduction of the velocity, even when the pollution is slight, solid particles of the sewage will deposit, accumulate, putrefy, and give off offensive gases. Likewise, fluctuation of the water in a small polluted stream used for power purposes has a deleterious effect. If areas covered with water are uncovered when the water is drawn down, it is to be expected that putrefying sewage particles will at times be exposed to the air, and, if these are sufficient in quantity, offensive odors will be caused by the deposit. In such cases a greater dilution is required than when the flow is more constant and rapid.

When sewage is discharged into a tidal stream, or into salt water, other difficulties arise. Besides the deposits caused by a usual reduction in the velocity of flow, the effect of salt water retards the process of decomposition, and a larger dilution is necessary to prevent objectionable results than is necessary when sewage is discharged into fresh water under otherwise similar conditions.

The effects of temperature, too, may be of some importance when disposing of sewage by dilution. An increase of temperature produces a more rapid decomposition; the oxygen in the water is more quickly absorbed; and, if it is insufficient in quantity, putrefactive processes will prevail, and produce a nuisance. If the water is cold, the process of decomposition is slower; the oxygen contained in the water is used up less rapidly, and can be replenished from the atmosphere in some cases quite as fast; and a nuisance is less likely to result. At Duluth the low temperature of the water of Lake Superior has a marked beneficial effect upon the discharge of sewage into the same, so far as the rendering of a nuisance is concerned.

The effect of aeration is likewise important. When a stream descends rapidly, and especially when it falls precipitously over dams, the facility for aeration is increased, and a more rapid oxidation takes place. A stream having a steep profile can receive more sewage per unit than a stream in which the fall is slight.

When considering the effect of dilution, it must not be overlooked that the above table presupposes a thorough dispersion of the sewage throughout the water. It is necessary, therefore, in a given case, to consider the distance that must be traveled by the sewage before a complete dispersion is obtained.

It must also be understood that the flow of the stream, as given in the table, is supposed to be its minimum flow, which usually takes place in this latitude during the early autumn. At other seasons the

conditions will be better than those indicated, in proportion as the quantity of flow is greater.

When sewage is discharged into a tidal stream, it is diluted only by the fresh-water flow from the watershed, which flow alone should be considered. The tidal oscillation, however, while not assisting the dilution, will hasten the dispersion of the sewage. The rapidity of dispersion will vary with the local conditions, the currents, the velocity, and the specific gravity of the diluting water. The Boston sewage discharged into the ocean at Moon Island with the outgoing tide is lost to view after it has gone one and one-half miles.

There has been much speculation concerning the self-purification of sewage-polluted streams. No doubt such purification takes place in some degree, although it is often confounded with the much greater improvement caused by a natural increase of flow and therefore by a greater dilution. The actual self-purification is to be attributed partly to subsidence, partly to the oxidation of organic matter, and partly to the destruction of organic matter by small animals and plants.

The effects of these three causes are slight compared with the effect of dilution, but they are active, and they assist the desired process. Although every rain brings into the rivers large quantities of impurities, they gradually disappear, and the rivers regain their natural purity.

Subsidence has a marked influence in clarifying a river when the velocity of the water diminishes. Oxidation is a slower process, and is dependent mainly upon bacterial life and the conditions favorable to it.

Small animals and, to a less extent, plants assist the process under suitable conditions. Says Dr. Sorby (*Journal Royal Microscopical Society*, 1884, pp. 988, etc.): "Taking all the facts into consideration, it appears to me that the removal of impurities from rivers is more of a biological than a chemical question, and that in all discussions of the subject it is most important to consider the action of minute animals and plants which may be looked upon as being indirectly most powerful chemical agents." To get the best results from such animals and plants the sewage must be delivered fresh, as their action ceases after putrefaction has begun.

Sometimes, when sewage is discharged into a stream to be used for a water-supply, an artificial purification is not only desirable, but necessary; there are other cases, however, where it will better satisfy the interests of the community to give up the river to the reception of sewage. In other words, there are cities where it is more expensive to thoroughly purify the sewage than to obtain a pure water-

supply, either from another locality or by filtering the sewage-polluted river water.

We have an example of the latter case in the cities of Hamburg and Altona, in Germany. Here the sewage from a population of about one million inhabitants is discharged into the river Elbe. Yet the same river, under conditions allowing of a considerable pollution, is used as the source of water-supply for both cities. But the water is now subjected to so thorough a purification that it is doubtful whether disease which has its cause in the polluted raw river water is transmitted by it.

The disposal of sewage by dilution is therefore satisfactory in many places, the main conditions being that at all times the flow of the stream receiving the sewage shall be sufficiently copious to so disperse and dilute it as to prevent putrefaction and substitute oxidation. When sewage must enter a stream subsequently used for a water-supply, it better answers the demands of sanitation and economy to thoroughly purify the water-supply, and allow the sewage to enter the stream by which it is well diluted, than to purify the sewage, and, further down the river, allow its raw water to be supplied for domestic use.

THE CYANIDE PROCESS AS APPLIED ON THE RAND.

By W. Leonard Holms.

IN 1890 the African Gold Recovery Company introduced the cyanide process into the Witwatersrand. Many other methods for the treatment of tailings had been tried previously, with no very satisfactory results, and, in the opinion of the majority of mining men, the new process offered no greater prospect of success. As shown, however, by the experience of the past seven years, the cyanide process is the most important advance in gold metallurgy achieved since the Rand became a mining centre. This fact will be better appreciated when it is noted that not half-a-dozen mines in the Transvaal would to-day be working at a profit, if the tailings were left untreated. During 1897 the total output of gold on the Rand was 3,034,678 ounces, of which tailings treated by cyanide yielded 934,545 ounces, or $30\frac{1}{2}$ per cent. of the whole return.

When the process was introduced, the capacity of the plants was very small, twenty tons of tailings a day being considered a large quantity to handle. The consumption of cyanide was exceedingly high, amounting in some instances to as much as three or four pounds per ton treated. The extraction was for the most part disappointingly low, and, when tailings began to be received direct from the battery, the percentage of leachable pulp recovered was comparatively small, probably, on an average, not more than 60 per cent. To-day there are few plants in operation which have a daily capacity of less than one hundred tons; several are capable of treating more than 450 tons; and at the Simmer & Jack Proprietary mines works have been built to handle more than 1,100 tons per diem. The average consumption of cyanide is, approximately, .66 pounds to .75 pounds per ton treated. The average extraction is 75 to 80 per cent., and the amount of treatable pulp recovered from battery tailings 70 to 78 per cent.

The cost of working varies with size of plant, natural facilities of location, etc., but the average cost per ton may be taken at 3s. 6d., which figure includes handling of tailings before and after treatment. Seven years ago the cost per ton was sometimes as much as thrice this amount. The chief factors in effecting this reduction in working expenses have been improvements in the construction of plant, decrease in the quantity and price of cyanide used, and increase in the quantities of tailings handled in individual plants.

It is impossible, in an article such as this, to detail the steps by

which the present perfected cyanide plant has been evolved, but a brief description of the type of plant and *modus operandi* generally adopted will not be out of place. On leaving the battery plates the tailings are connected by launder to the cyanide plant. Unless exceptional fall is afforded by the location of the latter, the pulp is raised by tailings pump or elevating wheel* to the required height above the vats. From the discharge point it flows through a series of spitzlütten, which eliminate the coarser sands and pyrites, amounting altogether to 10 or 15 per cent. of the total quantity treated in the works. The spitzlütten usually employed for this purpose are 4 inches by 2 inches by 3 feet 6 inches. The clear-water-supply to these should have a head of not more than 12 inches above the surface of the pulp in the spitzlüte; otherwise inconveniently small discharge-orifices must be used, or an altogether unnecessary amount of water employed. Nozzles less than $\frac{3}{4}$ of an inch in diameter are liable to choke, and are, therefore, objectionable. The balance of the pulp which passes through the spitzlütten flows thence into the collecting vats. There are two methods of filling the latter. The first is effected by means of a large base pipe, which is moved about the vat intermittently by a native, who distributes the sand as evenly as possible over the entire surface. In this case the excess of water carrying the "slimes," or clayey portion of the ore, escapes from the vat over a species of sluice-gate, which is raised periodically as the accumulating sand rises in the vat. The second is effected by means of a Butters & Mein's distributor. This apparatus consists of a flat, conical hopper revolving on a spindle, which is fixed on a column set in the centre of the vat. From the hopper radiate horizontally a number of pipes with bent ends. When the pulp is admitted into the hopper, it passes through the bent ends of the pipes, and imparts a rotating motion to the whole apparatus. As the pipes are of various lengths and diameters, an approximately equal distribution is obtained over a series of concentric circles. The water and slimes may be allowed to escape, as in the first method, or the vat may be filled with an annular launder, into which the water overflows as soon as it reaches the top of the vat. Whichever of these methods is adopted, it is usual to let the slime water pass through a small spitzkasten after leaving the vats, in order that any fine, but leachable, sands which have been carried over mechanically may have an opportunity of re-settling. The discharge-pipes from the spitzkasten are connected with the feed to the tailings pump or elevating wheel, so that the recovered sands are again carried into the vats.

* Made of wood or iron, or a combination of both, and varying from 25 to 50 inches in diameter.

When the vat is completely filled with sands, it is allowed to stand for a period varying from twelve to twenty hours, according to its size and the leachability of its contents. During this time the water which it contains is drained off as completely as possible through the leaching pipe. Unless artificial suction is applied, the vat will still contain about 15 per cent. of moisture at the end of this operation. If the tailings are perfectly fresh and unoxidised, as is almost invariably the case, a very weak solution of cyanide—say, 0.02 per cent.—is pumped on, until the charge is completely saturated and covered. The sand being fed into the vat with water, it packs hard, and makes the percolation of the solution a difficult matter; thus sometimes several hours will elapse before the vat is completely saturated. For the same reason little or no gold is actually dissolved out in the collecting vat, as the interstices between the particles of sand are comparatively minute and do not readily permit an adequate quantity of air to pass down through the sand with the solution. The object, therefore, of putting on solution in these vats is not so much to dissolve gold as to thoroughly impregnate the whole mass with cyanide solution, which, on being subsequently brought freely into contact with the atmosphere, acts energetically on the gold contents. After the solution has stood for a few hours on the vat, it is drained off through the weak liquor precipitation boxes, and, when the moisture in the sands has been reduced, as before, to 15 per cent., the vat is ready to be discharged into the leaching vats. The latter are now usually erected immediately beneath the collecting vats, which are fitted with several bottom discharge doors,* so that the transferring of the sands from the one vat to the other is done at a minimum of expense and with the utmost dispatch. As the tailings fall through the space between the two vats, they are brought well into contact with the air, and, moreover, any lumps which may have been formed during deposition in the collecting vats are broken by the fall and thereby rendered leachable. The contents of the leaching vats are, therefore, in every way better fitted for treatment than when they were in the collecting vats. The interstices between the sands are much larger, as may be judged from the fact that the cubic capacity of the leaching vats has to be some 20 per cent. greater than that of the collecting vats; therefore, free admission of air and uniform leaching are attained. As soon as the sands have been transferred, they are levelled off, and a medium cyanide solution (about 0.35 per cent.) is pumped on, until there is sufficient to displace the previous weak solution and saturate the mass thoroughly. This solution is

* Originally introduced by Mr. Charles Butters.

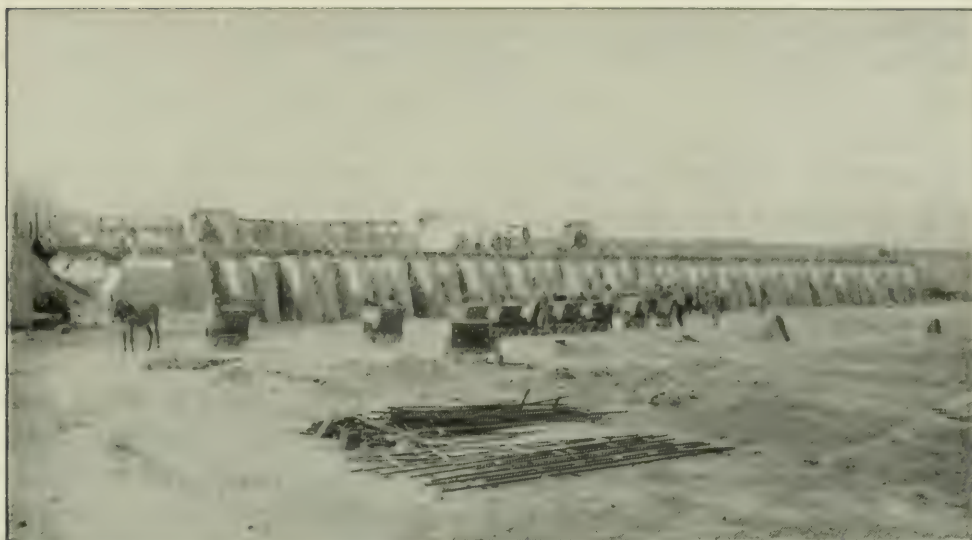
allowed to percolate slowly through the tailings, and a couple of hours after it has disappeared from the top of the vat a strong cyanide solution (0.10 to 0.08 per cent.) is pumped on. This strong solution is kept continuously percolating, fresh quantities being pumped on periodically, as required. It is necessary, however, to allow an hour or two to elapse between the time that the tailings are uncovered and the next pumping, in order that a sufficient supply of air may be drawn down by the descending solution. When sufficiently strong solution treatment has been given, medium solution is pumped on, followed by weak solution, the quantities in each case being so calculated as to thoroughly displace the liquor previously occupying the vat. If the state of the solution storage vats will admit, a final water wash is given to displace the solution last put on; but, as this is not practicable, as a rule, the vat is usually drained as dry as possible and discharged, the sands containing about 15 per cent. of the weakest solution. As this solution rarely assays more than ten grains of gold per ton, the tailings are enriched thereby to the extent of only 150 grains per ton. The discharging of the vats is accomplished through bottom discharge doors into 20 cubic feet trucks, which pass under the vats through passages left in their foundations. When full, the trucks are run out on a gradient to an endless rope tramway, on which they are hauled up to the residue dump and tipped. From the commencement of treatment in the collecting vats to the time of final discharging about 130 tons of solution of all strengths are used for every 100 tons of sands, and the total time so occupied is about four and one-half days.

The pyritic product obtained from the spitzlütten, as described above, is treated much as are the ordinary sands, but the time occupied and the amount of strong solution used are very considerably increased. From eight to twenty days may be required to obtain a satisfactory extraction, and the amount of strong solution employed may be three or four times as much as in the case of the sands. The collecting vats are much more freely employed for cyanide treatment when the spitzlütten products are dealt with, as the latter contain practically no slimes or fine sands, and are thus not liable to pack hard, but, on the contrary, afford a very good uniform filtering medium. For this reason strong solution treatment is commenced in the collecting vat, and the precise time at which its contents are to be transferred to the leaching vat is determined merely by convenience.

The precipitation of the gold is effected either on zinc shavings or by the Siemens-Halske process. Both of these methods have been so often described that it is unnecessary to explain them minutely. In the zinc process the solution passes upward through a succession of

compartments containing zinc shavings resting on a movable tray formed of coarse screening. The gold is thrown down as a fine powder, and replaced in the solution by zinc. In the Siemens-Halske process the solution flows through compartments very similar to those of the zinc box, but the zinc shavings are here replaced by lead strips or shavings hung between iron plates placed vertically and in the direction of the length of the box, about $4\frac{1}{2}$ inches apart. The lead strips are connected with the negative, and the iron plates with the positive pole of a dynamo, and the solution is thus electrolytically decomposed, the gold being plated on the lead cathode. The iron plates are wrapped in canvas, to prevent short circuiting. The current employed is from 250 to 300 amperes, which gives a current density of about 0.06 ampere per square foot of cathode. The standard size of precipitation box is 32 feet by 5 feet by 5 feet, and is divided into twelve compartments, in each of which are thirteen iron plates 26 inches by 48 inches by $\frac{3}{16}$ of an inch wide. The lead strips are about $1\frac{1}{2}$ inches wide, cut from sheets weighing 0.15 pounds per square foot. The rate at which the solution flows through such a box is about three tons an hour. The zinc process has the advantage of being less expensive to install than the Siemens-Halske, and is simpler to work, while the clean-up of the gold is an easier operation. The Siemens-Halske process has, however, an almost inestimable advantage over the zinc method in its power of precipitating gold from the very weakest solutions of cyanide; the zinc shavings are not satisfactory when employed to precipitate gold from liquors running lower than 0.04 per cent. in cyanide. The importance of this fact will be better appreciated when it is remembered that, in plants for the treatment of slimes, solutions much weaker than 0.04 per cent. are in use, and therefore, if the zinc method is employed at an ordinary tailings treatment works, and a plant be subsequently erected to work the slimes, a Siemens-Halske precipitation plant must be put up side by side with the existing zinc boxes, and two distinct systems must be run simultaneously, thereby involving much useless labour, as the two sets of storage vats must be kept entirely separate. A further point in favor of the Siemens-Halske system is the low consumption of cyanide, which is rendered possible only by the very weak solutions which can be used without interfering with satisfactory precipitation. The cost of actual precipitation is about the same by either method.

In giving the foregoing outline of the ordinary *régime* of Rand cyanide treatment the writer has assumed the plant to be fitted with Siemens Halske boxes, and has given the strength of the solutions employed accordingly. A plant operating with zinc precipitation



CYANIDE VATS; AN OLD STYLE INSTALLATION.

The concrete vats have generally been superseded by wooden ones.

would, of course, use solutions of considerably greater strength. On the Rand the ores are simple, and contain, as a rule, no base constituents other than iron pyrites; yet, even under such conditions, the electrolytic method is slowly ousting zinc as a precipitant. If the ores were complex and contained base metals readily soluble in cyanide, the relative merits of the two processes would be much more strikingly illustrated, as the use of very weak solutions would, in many instances, be absolutely essential to satisfactory treatment. Many other methods of precipitation have been tried, but none have come into common use. The Bettel process, in which zinc is employed as a cathode, is now being tried, with promising results, at the New Comet mine, and the Zerener and Sulman processes will in all probability make their appearance on the Rand shortly. In the former sodium amalgam (electrolytically formed) is used; in the latter, zinc fume in a special patented apparatus.

The question of first cost is a serious one in so isolated a centre as Johannesburg. Roughly speaking, a well equipped modern cyanide plant costs not less than £300 per stamp. This figure includes tailings wheels, mechanical haulage, rails, trucks, power installment, collecting vats, leaching vats, spitzlütten, spitzkasten, solution storage vats, precipitation house and plant, foundations and excavations, pumps, pipes, launders, etc.

The problem of slimes treatment, which so long stood unsolved, has been overcome by the perseverance of Messrs. Butters and Von Gernet, of the Rand Central Ore Reduction Company, and Mr. J. R. Williams, consulting metallurgist to the Crown Reef Mine. The

former agitate the slimes with about twice their weight of weak cyanide solution in vats fitted with mechanical stirrers. When the gold has gone into solution (after about four hours' agitation), the slimes pulp is settled by means of lime, and the clear liquor decanted off and precipitated in Siemens-Halske boxes. A fresh lot of still weaker solution is then run into the vat, and the stirrer (which is set just above the level of the settled pulp) re-started. When the whole of the pulp is again in suspension, the stirrer is stopped, the slimes are settled, and the liquor is decanted off as before. Finally, the slimes are stirred up with water and discharged.

The precipitation plant has to be very large, as four to five tons of liquor have to be precipitated for every ton of dry slime treated.

Mr. Williams's method differs somewhat from the other in mechanical details, but otherwise the two processes are identical. In both cases all solutions are precipitated electrolytically, the boxes being made twice the size of those used in the ordinary sands treatment.

In order to reduce the volume of the slime water (as it comes from the small sands spitzkasten at the cyanide works), it is passed through very large settling spitzkasten before being admitted to the slimes works proper. Five or six pounds of lime are added to every ton of slime contained in the slime water, before the spitzkasten is reached, and, if the settling area of the latter be sufficient, nothing but clear water overflows from it, the slimes being completely deposited in transit. Before entering the spitzkasten the proportion of water to solid slime is about 30 to 1, but the slime product discharged from the spitzkasten delivery-pipes is concentrated down to a ratio of 3 to 1. This



CYANIDE VATS; THE TOP OF AN OLD STYLE INSTALLATION.

thick pulp is again settled in a vat, and the clear water decanted off, leaving a slime product consisting of water and slimes in the ratio of 3 to 2 and ready for treatment as already described. To settle the slimes from a 100-stamp mill it is necessary to have a spitzkasten 35 feet by 25 feet, divided into thirty-five compartments, each 5 inches square by 5 inches deep. As the water flowing off from the spitzkasten is immediately pumped back to the battery reservoir, there is a comparatively small quantity in circulation altogether, and this becomes so thoroughly impregnated with lime that it is not necessary to continue adding the five or six pounds above mentioned. This prac-



BOTTOM OF CYANIDE VATS, SHOWING CARS FOR EMPTYING.

tice of circulating a limited amount of water for battery purposes may lead to novel developments in metallurgical practice on the Rand. As pointed out by a recent writer, it is conceivable that, through this innovation, a radical change may be effected in ordinary milling practice by the substitution of a weak solution of cyanide for water in the mortar boxes. There is apparently no reason why this should not be done advantageously. The quantity of solution in circulation would not amount to more than five or six tons per stamp; there would be no chance of loss of liquor beyond that entailed by causes at present in operation; a considerable proportion of the fine gold of the slimes would be dissolved with great rapidity in the mortar boxes, owing to the free access of air to the latter and the intimate contact of each particle with the solution; and, lastly, the solutions in use at the Sands

Cyanide Works would not be diluted, as at present, by the water delivered with the tailings. If it was found that the gold was effectively dissolved before the slimes reached the slimes works, the latter could be curtailed in size, as only settling and washing would be necessary in the way of treatment prior to precipitation of the liquor.

Another disputed question on the Rand is that of dry crushing and direct cyaniding. It has frequently been urged that the present method of treating the Rand ores could be improved upon by abandoning amalgamation altogether, crushing dry, and extracting the gold by means of cyanide only; but, though several attempts have



A CLEAN-UP ROOM.

been made to verify this theory, the results of such departures have been disappointing. Where oxidised surface ores have to be dealt with, no doubt dry crushing followed by cyaniding may be made to work satisfactorily. This is due, first, to the fact that such ores are in a more or less porous state, and may therefore be crushed very coarsely, as the cyanide solution can thoroughly permeate each particle, and, secondly, to the fact that the original auriferous pyrites has been completely oxidised, and therefore gives a higher and quicker extraction when subjected to cyanide. The percentage of such ore, however, is very small, and the material which really has to be considered is the pyritic, or "blue," rock of which the vast bulk of the Rand ores now being worked consists. A totally different problem is presented here. The rock contains a large amount of



TOP OF TAILING VATS, CYANIDE WORKS, SHOWING TRACKS AND SCREENS FOR FILLING.

pyrites, much of which is comparatively coarse. If dry crushing and direct cyaniding are to be employed, it will be necessary to crush very fine, in order to expose as many surfaces as possible to the solvent. If, however, the crushing be carried beyond a certain limit, a large proportion of fines will be formed, and these again will prevent, or greatly impede, subsequent leaching. As this would be inadmissible, the crushing can be conducted only within such limits that in the final product there will be a very appreciable amount of coarse pyrites. To extract the gold from the latter a prolonged cyanide treatment is necessary, but, as it is impossible to concentrate dry economically, the same length of treatment must be given to the whole ore crushed, thus involving a plant of enormous dimensions. As it does not seem probable that the costs of actual crushing could be lessened by substituting dry for wet milling, the only apparent advantage that can be claimed for the former is the comparatively low cost of installation, against which, however, must be set the increased expenditure on cyanide plant necessitated by its adoption.

In conclusion, it may be remarked that, although it has often been said that "the cyanide process made the Rand," yet, if we remember that the process had been worked with indifferent success previous to its introduction to South Africa, we may with equal justice say that "the Rand made the cyanide process."

RECENT APPLICATIONS OF ELECTRO-CHEMISTRY TO THE METAL INDUSTRIES.

By Sherard Cowper-Coles.

ELECTRO CHEMISTRY and metallurgy are beginning to play an important part in large engineering works; for instance, electricity is being employed for electro-galvanizing, removal of mill scale, manufacture of copper tubes and condensers, production of metallic reflectors, brass-plating of iron and steel fittings of ships, and recovery of tin from tin scrap. It is also being introduced in allied industries, such as the manufacture of white lead. The first of these processes referred to—*viz.*, galvanizing—is extensively used for coating the frames and plates of torpedo-boat destroyers and for galvanizing tubes for water-tube boilers, such as the “Belleville.” One feature that makes this process particularly suitable for this class of work is that it does not hide defects or cover them up. Nor does it reduce the tensile strength of iron and steel of small section, or distort it, as in the case of hot galvanizing. But it shews up any defect or flaw in the steel, saving a considerable amount of time and money, as any weakness in the tube or plate is found out at an early stage instead of at the final stage. Other advantages of electro-galvanizing are that the plant can be worked intermittently without loss, and varying thicknesses of zinc can be employed at the will of the operator. The zinc usually applied to such work as boiler tubes weighs $\frac{3}{4}$ ounce to $1\frac{1}{4}$ ounces per square foot. The process of electro-galvanizing consists, first, in removing the mill scale and rust from the work to be galvanized, either by immersing in an acid solution or by sand blasting. It is then placed direct in the galvanizing bath,—a solution of zinc sulphate, about 30 ounces to the gallon of water. The work to be galvanized is suspended to a bar or girder running across the bath, by means of gun metal dogs; the electric current is conveyed into the solution by means of lead plates, the voltage at the terminals of the dynamo being about 6, and the number of amperes per square foot of cathode surface 15 to 20. The solution is rapidly circulated through the bath by means of a small centrifugal pump, and is regenerated, as the zinc is removed from it, by passing it over a filter-bed composed of carbon, coke, or sand mixed with zinc dust, which is obtained as a by-product during the distillation of zinc from its ore.

Fig. 1 shews a plant suitable for coating plates and angle irons up

to 25 feet in length, and Fig. 2 a plant specially designed for coating the tubes of Belleville boilers. Fig. 3 gives plan and elevation of a plant, shewing the regenerating tanks and circulating arrangements.

The removal of mill scale is a matter of considerable moment with many large engineering firms. The ordinary pickling process is tedious and costly, and electricity is now being used to hasten the process.

The removal of mill scale from forgings and plates has always been a matter of difficulty, the scale in many cases being $\frac{1}{32}$ of an inch in thickness, and very adherent. The usual practice is to place

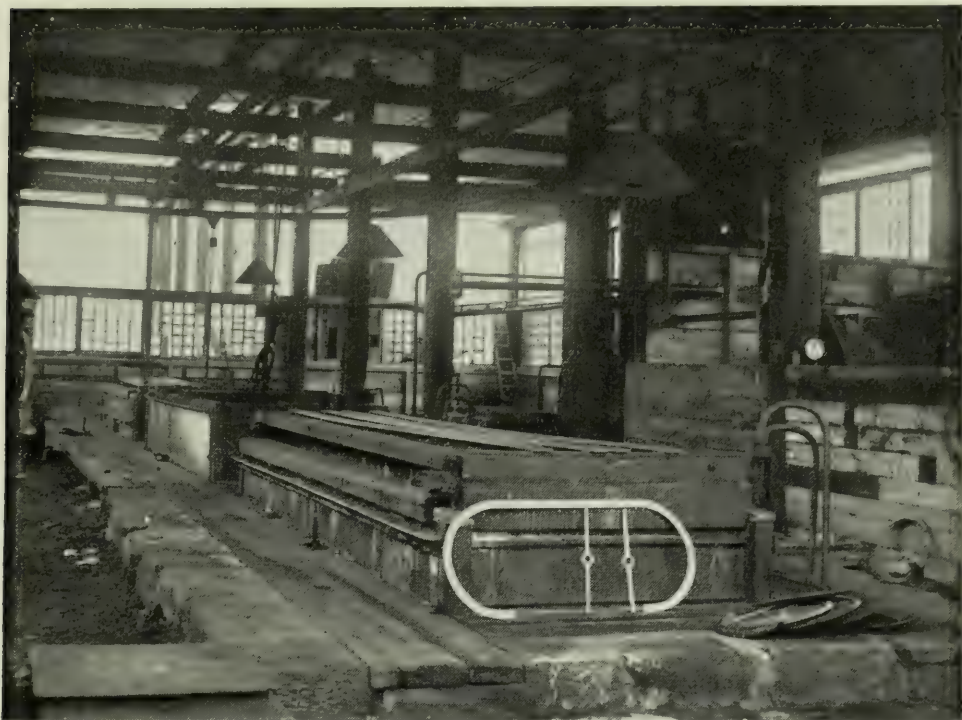


FIG. 1. ELECTRO-GALVANIZING PLANT FOR PLATES AND ANGLE-IRONS.

the iron in a solution, containing 1 part of hydrochloric or sulphuric acid to 10 parts of water, for a period varying from $\frac{1}{2}$ to 24 hours,— $\frac{1}{2}$ an hour for close annealed sheets, such as are used for roofing sheets, 24 hours for plates and forgings, such as are used for ship and bridge building. Many attempts have been made to quicken the process and to reduce the cost. One of the first experiments was to make the iron to be pickled the anode in an acid bath; this was found to pit the plates, as the iron which was not protected by the mill scale was more readily dissolved than that covered by the magnetic oxide. To overcome this difficulty, the current is reversed every few minutes, the iron being alternately made anode and cathode. Fig. 4 shews a transverse section of a pickling vat con-



FIG. 2. PLANT FOR COATING BELLEVILLE BOILER TUBES.

structed for such a process, the work being suspended on the bars placed across the vat. To quicken the process and reduce the electrical resistance of the solution, it is found advantageous to heat the pickling solution or electrolyte, which is done by means of a lead pipe, G, through which exhaust steam is passed. In the illustration, a tray or false bottom, B³, is shewn, capable of a vertical movement between guides provided on the inside of the vat, the object of the tray being to catch the heavy mill scale as it falls from the plates. The tray, at the end of the day's work, is allowed to float to the top of the solution, so that the mill scale collected can be removed. To sink the tray when necessary, extensions, B², are provided, at each corner, and these are connected to flexible connections which pass round guide sheaves and are attached to a drum or winch which is rotated when it is desired to sink the tray. To float the tray the pawls are released from the winch.

Another device for catching the scale soon after it is removed from the plates, so as to prevent the further unnecessary consumption of acid by dissolving the mill scale and oxide after removal, has been tried with most satisfactory results. The solution is circulated by means of a small pump through a lead-lined box or chamber, behind which are placed electro-magnets, the result being that, as the solution flows past the poles of the magnets, the magnetic iron and oxide

in suspension are retained, and can be removed from time to time, thus effecting a considerable saving of acid.

In America an electrical pickling process has been tried, the solution used being sulphate of soda or sulphuric acid. The plates to be cleansed form the negative electrode, and an iron plate the positive electrode. The hydrogen set free from the surface of the plate reduces the oxides on the surface, and decomposes any grease that may be present.

A voltaic method is said to do the work with more certainty and with less danger to the surface of the metal in the way of pitting.

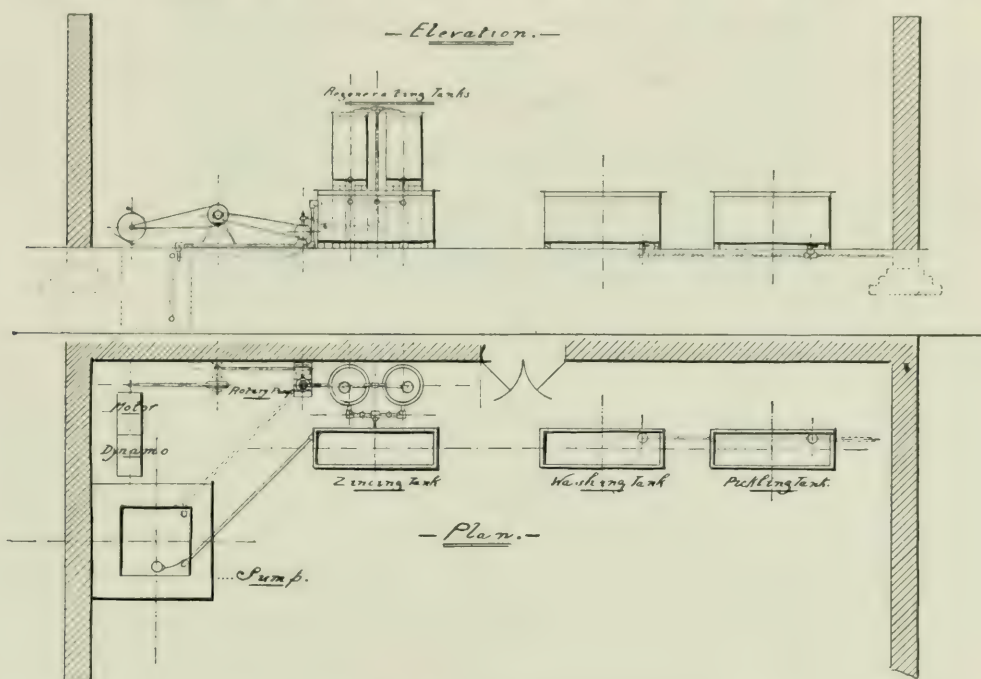


FIG. 3. PLAN OF ELECTRO-GALVANISING PLANT.
Showing Regenerating Tanks and Circulating Arrangements.

The articles to be cleaned are used as the positive pole of the battery, the negative pole being either carbon or wire gauze electro-plated with silver and covered with amorphous platinum black. The bath consists of dilute sulphuric acid, containing a depolariser, such as nitric or chromic acid. The use of the latter agent, it is claimed, completely prevents the evolution of offensive gases. The storage of the electric current produced during the pickling process has been suggested.

Attempts have been made to remove the mill scale by drawing it away from the plates with powerful electro magnets, the scale having been previously loosened from the metal by a short immersion in an acid bath or by heating.

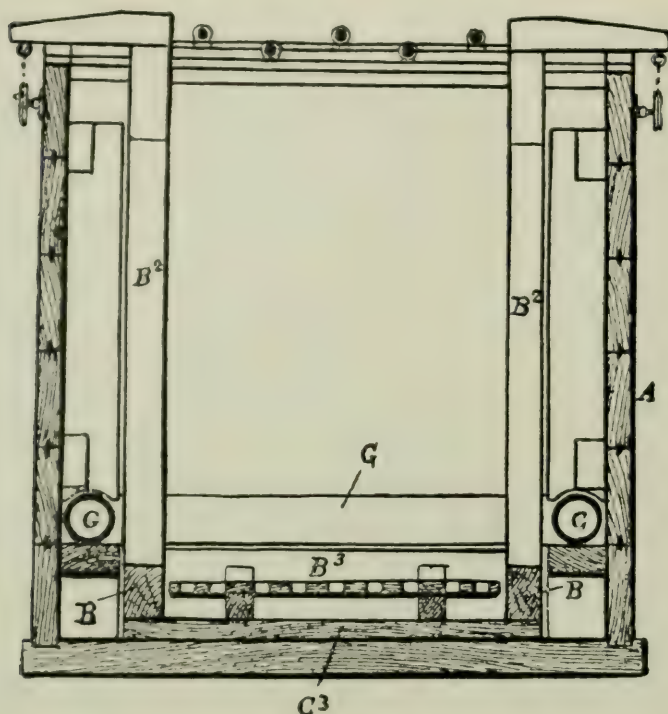


FIG. 4. PICKLING VAT FOR REMOVAL OF MILL SCALE.

Parabolic reflectors, which have hitherto been made exclusively of glass both for lighthouses and search-light purposes, are now being made by electro-metallurgical means. On a highly-polished surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished so as to make adherent the copper backing subsequently electro-deposited upon the silver. The glass mould, after silvering, is placed in a suitable ring and frame, as shewn in Fig. 5, and then immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position at a rate of fourteen revolutions per minute. The copper adheres firmly to the silver, and together they form the reflector, which is finally separated from the glass mould by placing the whole in cold or lukewarm water and gradually raising the temperature of the water to 120° F., when the metal reflector will leave the glass mould because of the unequal expansion of the two. The surface obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish. It requires no further treatment to answer all the purposes of a reflector, except that it must be coated with a film of some suitable metal, such as palladium or platinum, which is found to resist tarnishing to a wonderful degree.

The glass bells of electric incandescent lamps are now fitted with reflectors, the silver being thrown down chemically on the upper

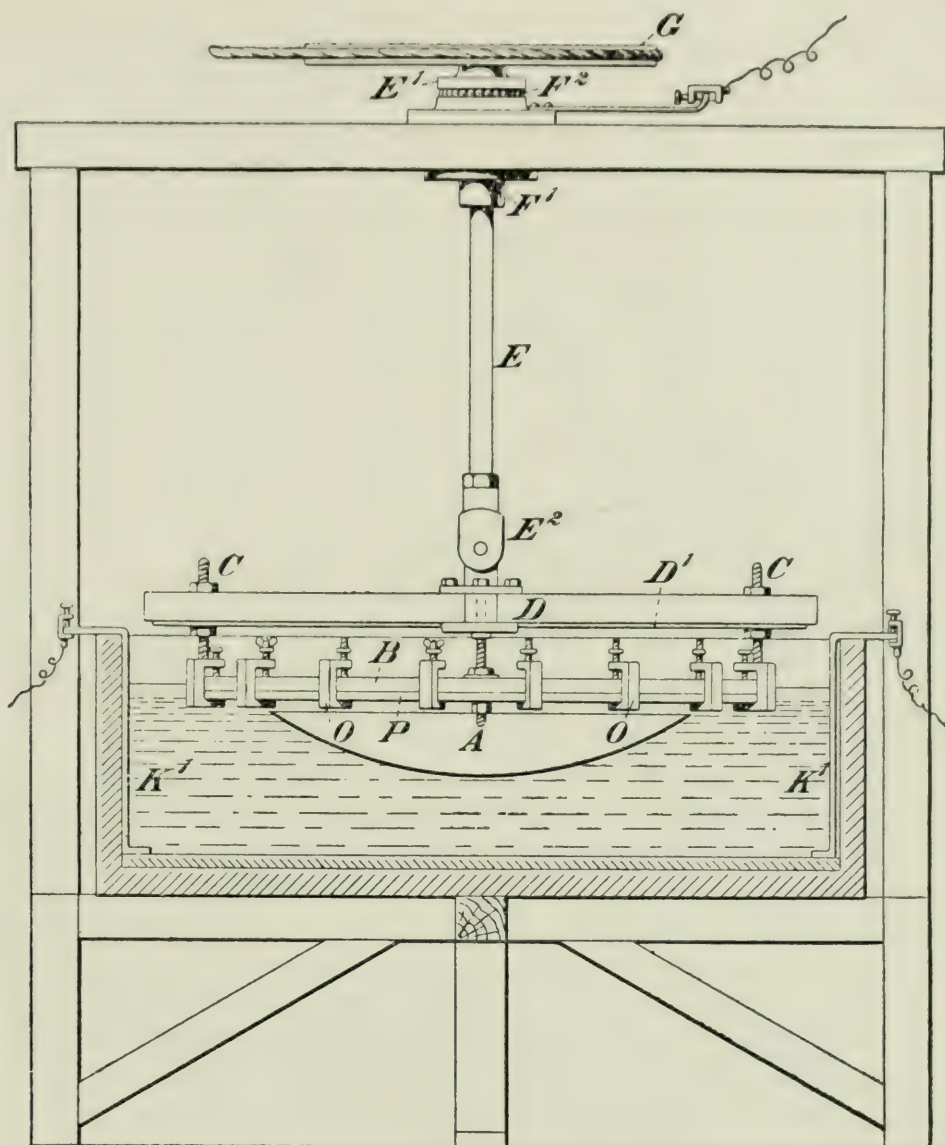


FIG. 5. APPARATUS FOR MAKING PARABOLIC REFLECTORS.

part of the glass bulb, and protected with a film of electro-deposited copper.

The deposition of copper is carried out in many large engineering works, for the coating of hydraulic rams, barrels of guns, and shot, and, as is well known, is now extensively employed in the manufacture of copper tubes for condensers and large evaporating pans.

Copper is being largely used for the coating of constructive iron work for protective and ornamental purposes. A large piece of work has recently been executed for the dome of the Philadelphia city hall tower. In this case 20,000 square feet of surface were coated with copper, the weight of copper deposited per square foot being 11

ounces. The iron work was boiled in a solution of caustic soda for the purpose of removing all grease or fatty substances. From this tank the iron castings were placed in a pickling tank made of wood, lead-lined, and containing a 10-per-cent. solution of sulphuric acid kept at a temperature of about 150° F., the iron work being immersed in this solution from two to six hours to loosen or remove all rust, silica, or other matter, and finally brushed with wire brushes. After this treatment the iron work was placed in an alkaline copper tank to receive the first coating of copper. From this tank, after a short immersion, the work was transferred to a copper sulphate solution, where it was kept until it had received the desired thickness of copper. As a final operation, the coppered iron was placed in a tank fitted with aluminium and tin anodes, where it received a further coating corresponding to 2½ ounces per square foot. It is claimed that this coating consisted largely of aluminium.

In many engineering shops, in the case of work in which strength combined with handsome appearance is required as well as protection from corrosion, iron and steel fittings are used with an electrically-deposited coating of brass.

The cells for depositing brass are similar in construction to those used for nickel plating, the anodes being of rolled sheet brass. The double salts of cyanide of potassium and copper give good deposits, when worked hot. The colour of the deposit can be altered from a bronze to a bright yellow either by rocking the work in the bath or by using different current densities. In many cases the bath is made up by first electrolytically dissolving sheet-brass anodes in a solution of cyanide of potassium, or by first dissolving the desired quantity of copper from a copper anode, and then dissolving the desired quantity of zinc from a zinc anode. A strong current density has a tendency to deposit a larger percentage of zinc, a weak current to deposit a greater portion of the more electro-negative element, copper.

The recovery of tin from tin scrap by electricity is carried out in nearly all districts where much tin scrap is produced. In Russia Nikolojev has established works at Nishni Novgorod producing 1,500 poods of tin (recovered from tin scrap).

A great number of processes have been patented, and satisfactory results have been obtained with solutions of sodium stannate. Alkaline hydroxide, especially caustic soda, has been also extensively employed, as the tin dissolves readily, and without the aid of electricity, in a warm solution of caustic alkalies, hydrogen being evolved. Iron, however, is almost entirely insoluble in such solutions, the electric current being used merely for precipitating the tin. A process has lately been brought out in America for extracting tin from tin-plate

waste. The waste tin plate is submitted to the joint action of a current of electricity and a bath consisting of a solution of caustic alkali, until the recovery of the tin is retarded or ceases and the bath becomes charged with tin salts. Phosphoric acid is then added, causing a precipitation of tin oxide. Calcium oxide is finally added to the bath, causing a precipitate of calcium phosphate. Acid solutions, such as sulphuric acid, have also been employed for the recovery of tin, but the process is found to be costly, as the amount of ferrous sulphate produced is very considerable,—for instance, 6 tons of tin scrap producing about 28 tons of ferrous sulphate, at present of little value.

Electrolytic methods are now being substituted for the slow and tedious Dutch method of manufacturing white lead. To hasten the process the following system has been devised by Prof. C. V. Gardner, and is being worked on a commercial scale by the Universal White Lead Co., at Millwall. The lead is cast into thin sheets about 20 inches by 15 inches, weighing between two and three pounds each. These sheets are corrugated and packed between sheets of coke or carbon, which form the negative electrodes; strips of tin make the connection between the lead or electro-positive plate and the carbon electrode, so that, when subjected to warm vapours of acetic acid, carbonic acid, and atmospheric air, electrical action is set up between the two, hastening the corrosion and lessening the time required to reduce the plates into hydrated carbonate of lead from ten or fifteen weeks (the time required by the old Dutch process) to five weeks.

Another electrolytic process consists in electrolysing a 10-per-cent. solution of sodium nitrate in a wooden cell provided with a porous diaphragm, the anode being made of pig lead and the cathode of copper. In the former compartments the lead dissolves as nitrate, while round the cathode caustic soda is produced. The two solutions are then drawn off and mixed, the alkaline nitrate being thus regenerated and the lead precipitated as hydrate. The hydrate is finally treated with sodium carbonate to convert it into white lead. The caustic soda formed as a by-product in the latter operation has only to be re-carbonated to be available again.

A somewhat similar process, patented by Mr. Brown, is carried out by electrolysing sodium or potassium nitrate solution in a wooden vessel divided by a porous partition into two cells, one of which contains pig lead and the other a copper cathode. A double salt of lead is formed at the anode, and alkaline hydroxide and free hydrogen at the cathode. The two solutions are mixed, lead hydroxide comes down, and alkaline nitrate solution is left, the original alkaline salt

being regenerated. The solution containing lead hydroxide in suspension is then run into a settling-tank, from which the clear solution is subsequently run off, when it is used again as the electrolyte, the lead hydrate being finally exposed to the air, or to an atmosphere of carbonic acid, to convert it into hydrated carbonate of lead.

Another process patented in America consists in passing an electric current from an anode of metallic lead, through an alkaline electrolyte consisting of a solution of salt of ammonia in combination with any acid which will produce a soluble lead salt (including sulphuric acid) and of a bi-carbonate of an alkali, to a cathode of lead, carbon, or other suitable material. This causes a decomposition of the salts in the electrolyte, and a formation of a soluble compound of lead, which is transformed into hydrated carbonate of lead; while the simultaneous generation of free carbonic acid at the anode in the presence of caustic alkali (ammonia) generated at the cathode, passing a current of carbonic acid gas through the electrolyte, regenerates the spent alkaline carbonate until the anode is completely dissolved. Both acetate and bi-carbonate of soda are constantly regenerated, the process consuming only lead, carbonic acid, and water.

An English process, which has lately been protected, consists in decomposing acetate of ammonia by electrolysis, lead anodes being used, which are separated by porous diaphragms made out of stout Willesden paper insulated from the bottom to prevent irregular electrolytic action in the electrolyser. A lead solution is produced; also caustic alkali; and on mixing the two solutions, white lead is precipitated.

In another process, patented in Germany, lead anodes three mm. in thickness are employed for the electrolysis of a solution containing 300 cc. nitric acid and 2,000 cc. of water. The lead salt formed is precipitated as white lead by means of a stream of carbonic acid gas. Any silver contained in the lead is deposited on the cathode, and can be recovered.

At a future date I hope to give particulars of various other electro-metallurgical and chemical operations in engineering shops.

THE ECONOMICAL USE OF STEAM IN NON-CONDENSING ENGINES.

By James B. Stanwood.

THE inadequacy of automatic variable cut-off devices for controlling the distribution of steam in non-condensing engines under great variation of load was discussed in an article in the May number of *THE ENGINEERING MAGAZINE*. The belief was expressed that control by means of a throttling governor would be more satisfactory, and this belief was endorsed by the opinion of an eminent American engineer and the practice of a celebrated English designer.

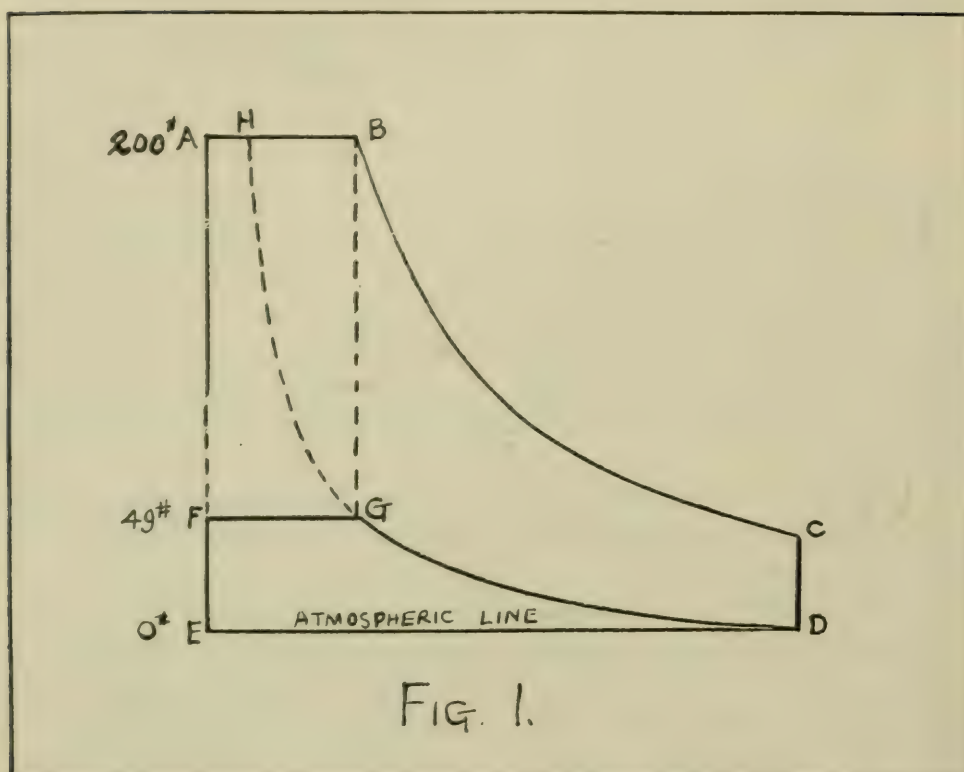
In this paper it is proposed to consider the advantages and disadvantages of throttling governors as applied to non-condensing compound engines.

The fundamental difference between the two systems is this: For variations in load, the expansion governor adjusts the mean effective pressure (m. e. p.) by varying the volume of steam admitted to the engine, the pressure being always constant; the throttle adjusts the m. e. p. by varying the pressure of steam admitted to the engine, the volume being always constant.

It was shown in the other paper that the small m. e. p.'s necessary for light loads can be produced only by automatic expansion gears in connection with three induced losses,—to wit, first, expansion below the atmosphere, called the “drag” loss; second, a clearance loss; third, a cylinder condensation loss,—each of which becomes greater, the smaller the m. e. p. and the lighter the load.

The distinguishing features of throttling governing are, first, that the “drag” does not appear until the m. e. p. is very small (with high steam pressure the “drag” can be prevented, except when the load on the engine is so small as to be but slightly greater than the friction of the engine itself); second, the clearance loss decreases as the m. e. p. and load decrease; third, the cylinder condensation loss decreases as the m. e. p. and load decrease.

Diagram 1 indicates how, by throttle control, without expansion below the atmosphere, a smaller m. e. p. can be obtained than by expansion governing. A B C D E represents the maximum diagram that can be obtained theoretically with 200 pounds' steam pressure (an extreme case) and four expansions; back pressure being 15 pounds absolute, the m. e. p. obtained is 110 pounds. Diagram F G D E represents the smallest m. e. p. that can be obtained with a terminal pressure of 16 pounds with four expansions, the initial press-



ure being 49 pounds, reduced to that pressure by a throttling governor; this m. e. p. is about 21 pounds. The diagram A H D E is the smallest that can be produced with a terminal pressure of 16 pounds under expansion governing which maintains a constant initial pressure; the m. e. p. of this diagram is 38 pounds—nearly twice that obtained by means of a throttle. In practice these m. e. p's cannot be secured, the actual being about two-thirds to three-fourths as great; but the diagram shows the relation existing between maximum and minimum loads under both systems of control.

The reason that there is a reduction of the clearance loss under throttling governing is due to the fact that the clearance spaces are filled with steam at low pressure when the load is light, because the initial pressure is reduced by the throttling effect of the governor; the steam, for instance, at 49 pounds' pressure weighs less than one-third of the weight of an equal volume at 200 pounds' pressure, reducing the loss accordingly.

It follows that, with a reduction of the initial pressure by means of the throttle, the initial temperature of saturated steam is reduced; therefore the fluctuation of temperature in the cylinder is less, thereby checking cylinder condensation. This shows that the cylinder condensation loss becomes less as the m. e. p's become small. Another

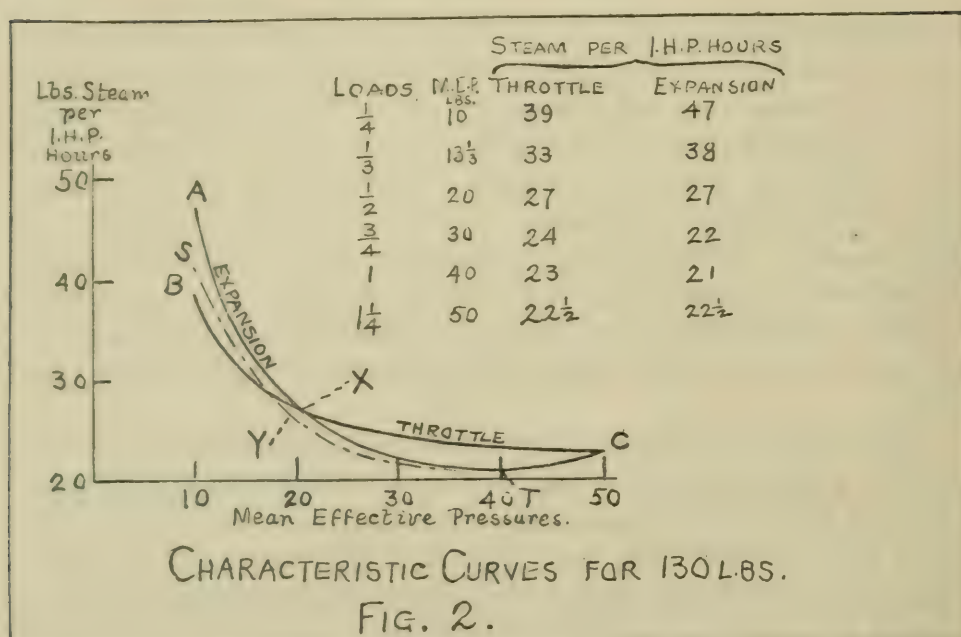
important consideration to be noticed is the fact that the steam is super-heated by the wire-drawing effect of the throttle, converting the saturated steam into super-heated steam. This super-heat in the steam becomes a source from which heat is drawn to reheat the cylinder (previously cooled by expansion and exposure to the exhaust) without unnecessary condensation of fresh steam from the boiler for that purpose. It will also be noticed that, as late fixed cut-offs can be used with a throttling governor, there is no tendency to excessive cooling of the cylinder on account of excessive expansion at early cut-off, as is the case with engines with automatic cut-offs under light load.

This shows that where expansion governing fails throttling governing has no disadvantages. The chief criticism on the score of economy that can be raised against the throttle is that, in the range between light load and over load, there is a point or range of load at which expansion governing is more economical, on account of the advantage it has in securing a rate of expansion greater than that which must be selected for throttle control, if the same maximum power is to obtain in each case.

This loss of economy by throttling governing (at about three-fourths load) can be almost entirely prevented, if a larger ratio of expansion be employed, equivalent to that which develops by expansion governing at its most economical point. This advantage, however, is obtained by a limitation of the engine's power, so that over-loads cannot be carried without an increase of steam pressure. It is also probable that the very light loads would be carried with less economy, on account of an earlier appearance of the "drag" and a slight increase of clearance and cylinder condensation loss, due to greater expansion.

A study of the "characteristic curves" of both types of engines will make these points clearer. The experiments of Mr. Willans form the principal basis for the determination of characteristic curves of throttling engines under variable loads, and the results have been partially confirmed by the writer's experience with this type of engine; they are also indicated by theoretical considerations. The most important fact to be noticed in connection with these curves, as is shown by Fig. 2, is that with throttling governing the water per i.h.p. decreases continually as the load increases, but with expansion governing the water per i. h. p. decreases at first with increase of load, until the best economy per i. h. p. is reached, after which it increases. A careful experimental investigation into characteristic curves of properly-designed engines of both types is most desirable.

In Fig. 2 the curve A X C represents the pounds of steam used



per i. h. p. per hour by an automatic cut-off non-condensing compound engine, steam pressure 130 pounds, maximum m. e. p., 50 pounds. Curve B X C represents the pounds of steam used per i. h. p. of a throttling non-condensing compound engine with the same steam pressure and maximum m. e. p. Thus the best economy is secured by the automatic engine at about 40 m. e. p., when the water rate is about 21 pounds; the water rates of both engines are identical at 50 pounds m. e. p., when it is about 22 $\frac{1}{2}$ pounds per i. h. p. On light loads, however, the water rate on the throttling engine is much less than with the automatics, on account of the flatter character of the throttling curve from X to B. The point X, where the two curves cross, is the point at which the gain by expansion in automatic engines is neutralized by induced losses. The dotted line S Y T shows throttle characteristic for maximum economy—no over-load.

Fig. 3, although out of the range of experience, shows the characteristic curves which the writer expects, with 200 pounds' steam pressure, for both throttling and automatic engines. The throttle has the longer period of nearly constant economy,—from 15 pounds, m. e. p. with a water rate of 31 pounds to 75 pounds m. e. p. with a water rate of 21 pounds.

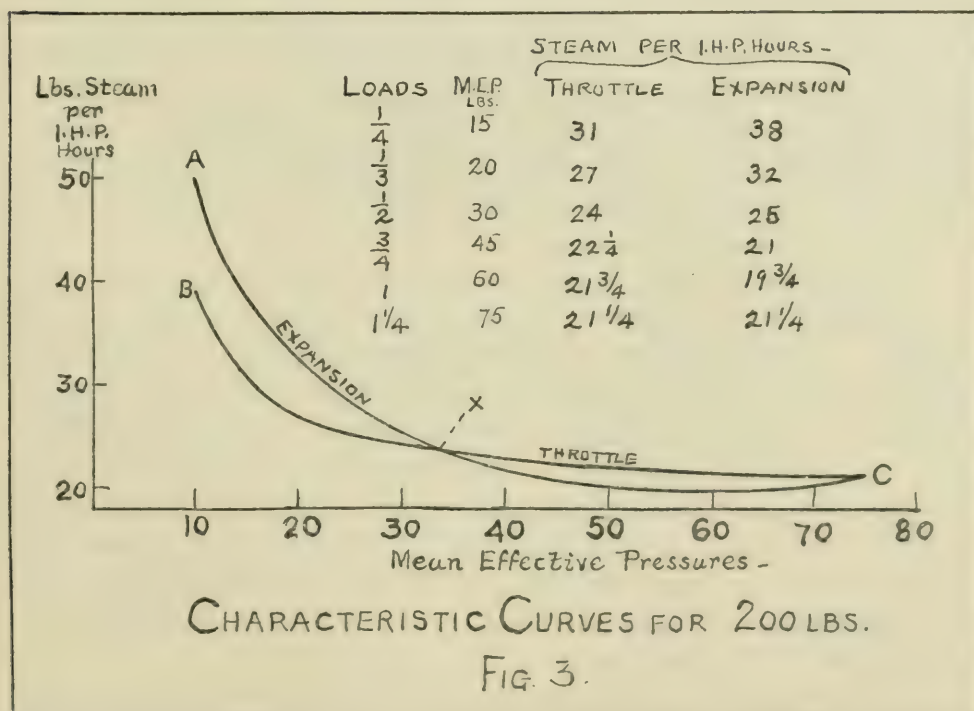
In addition to marked economic advantages at light loads, a number of mechanical advantages are offered by throttling governing.

As was pointed out in the May number, the low-pressure cylinder of a non-condensing automatic compound engine is frequently converted, under light loads, into a pump which has to be dragged along

by the high-pressure cylinder ; this condition, in connection with the development of a loop in diagrams taken from the high-pressure cylinder, makes it impossible, with certain classes of valve gear, to operate these engines quietly at light loads. Indeed, it is only with piston valves, or the best forms of balanced valves, that compound non-condensing automatic engines can be made to run at all smoothly under light load. Even then the engine must be of the tandem type, in order to secure by the net action of both pistons a positive pressure upon the crank pin. This unmechanical arrangement is also necessary whenever the main shaft governor is employed, and the adjustment of the cut-off of both cylinders has to be brought under the control of the governor, because the complication and expense of the valve gear are greatly increased in engines of the cross compound type, especially with cranks at right angles.

On the other hand, these difficulties can be avoided, if a throttling governor is used ; its employment makes the non-condensing cross-compound engine practicable. The principal reason is that the low-pressure cylinder continues to perform work with the very small m. e. p's which accompany light loads, without the development of any very serious " drag," and that no loop appears in the high-pressure diagram.

The superiority of cross compound engines with cranks arranged at right angles are numerous. First the fluctuations of impulses which



the fly-wheel receives from the engine are small, so that a very light fly-wheel may be employed ; or, if the variations of load are very severe, nearly all the momentum of the wheel is available for steadying the action of the engine. On this account very sensitive governors can be used. Second, the pistons of both cylinders are very accessible. And, third, the magnitude of the strains in the engine are only one-half of those developed in a tandem engine of a similar power.

All these and other advantages are secured by using the throttle.

Engines of the throttling type can be operated successfully at almost any speed, especially at low speed, as the fly-wheel is not called upon to carry the entire load of the engine every time a crank passes a center, and the valve gear places no limitations upon the number of revolutions. Again, in case of repairs for either high- or low-pressure engines, one or the other may be operated singly under control of the governor at half-load. In this connection the engines can be converted into a pair of simple engines, still under control of the governor, by a simple application of a three-way valve with proper pipe connections placed between high- and low-pressure cylinders. The value of such an arrangement appears when the steam pressure is unavoidably low and the loads are exceptionally great.

There are two serious objections to throttling governors. One, already mentioned, is that, in order to secure the most economical results for light and over-loads, the best possible rate of expansion (which corresponds with a range of load from one-half to full load) cannot be obtained. It is obvious that, if a small ratio of expansion is required for a light load and also for an over-load, and if that ratio of expansion must necessarily be fixed, a greater ratio of expansion, which may be more economical, has to be abandoned. On the other hand, the gain in economy in non-condensing compound engines from increasing the ratio of expansion is very slight, as is shown by the characteristic curves.

The second objection relates to close regulation. As a rule, compound engines of any type do not govern as closely as single-cylinder engines. A great amount of time and attention has been bestowed upon the main shaft governor in connection with single cylinder high-speed engines, producing an instrument of marvelous simplicity and a high degree of refinement ; but throttling governors have never received the same amount of study and care. In England the throttling governor, in the hands of Mr. Willans and others, has been developed to some degree, and the status to-day is this : the throttling governors control as closely as the best main shaft governors of three or four years ago.

It has always been a serious problem in the growth of industrial

plants to prepare for the proper increase of power. The range of speed for most types of engines is limited by the form of valve gear or governor. Now, the power of the engine (provided it is sufficiently strong and suitably designed) can be increased by increasing its speed and its boiler pressure. The cross compound throttling engine possesses superior advantages in this respect ; it can be operated at almost any speed and at any boiler pressure. On this account an engine can be installed at a low number of revolutions, corresponding, say, to 400 feet piston speed and 100 pounds' boiler pressure, and can be operated with economy equivalent to that of a good Corliss engine similarly loaded. Later the piston speed can be increased gradually to 600 feet, if necessary, and the boiler pressure to 150 pounds, thereby increasing the maximum power of the engine 125 per cent., and securing also a gradual improvement of economy. The increase of engine speed can be obtained by enlarging the receiving pulley on line shaft or generator, as loads may determine. There is no difficulty to-day in providing for 150 pounds' working pressure in the boiler. To the writer's knowledge there is no other way by which so great a range of power can be obtained with non-condensing engines, at the same time maintaining so uniform a degree of good economy.

To sum up, we find that throttling governing, with non-condensing stationary engines, is especially adapted for high steam pressure ; it improves an engine's economy at light loads ; it makes the cross compound engine practicable, and thereby produces a type of engine which may be operated at any speed. It is believed that, when these advantages are more thoroughly understood, the throttle will receive more attention from designers, and that improved constructions and methods of application will be evolved.

EFFECTIVE SYSTEMS OF FINDING AND KEEP- ING SHOP COSTS.

By Henry Roland.

THE Newton Machine-Tool Works, located at the corner of Twenty-fourth and Wood streets, Philadelphia, puts out a line of cold-metal sawing machines, milling machines, and traversing, spindle, boring, milling, and drilling machines of new and most convenient designs, now rapidly winning their way to established reputation.

The theory of expense-division underlying the cost-keeping system in use at the Newton shops is the same as that at Strieby & Foote's, in that the total expense account is apportioned among the machine tools, so that each shall bear its proper hour-rate, making the materials and time charged against any piece of work represent the total cost of the product to the shop. The Newton shops are a machine shop exclusively, having neither foundry or smithy. As their machine-tools are comparatively numerous, and their floor-hands few, the machine tool rates fix the principal part of the costs. It is quite within the capacities of the individual tool hour-rate system, however, to deal with any ratio of floor-hands to machine-hands, as the floor itself can be assumed to bear any suitable share of the expense account, a division of which share by the average number of floor-hands gives the total cost of the floor man's work-hour, precisely as the machine hand's total hour-cost is obtained.

There seems to be really no essential difference in the practical workings of cost systems, let the expense account divisor be what it may. If the total expense of the preceding year is divided by the total actual labor cost of that year, as in the Bement and Miles method, then with less men at work the expense percentage to be added to the labor account and materials totals to obtain total-cost is too small. So, if a tool or several tools stand idle, their proportion of the expense account remains unchanged by the Strieby & Foote and Newton method. Evidently the only, or rather the most obvious, correction of this deficiency is to be found in a sliding scale of percentage per man at work. As has been before mentioned, a reduced force of workmen does not mean a corresponding expense reduction; these two cost factors are wholly independent of each other, so that it is possible that the larger total expense account will be made with the smaller number of hands at work. In the fluctuations of trade there might be a reduction of 50 per cent. in the number of hands at work, without any decrease in the expense account total; in fact, the

latter might even be augmented through extraordinary efforts to obtain business. With a constant or nearly constant number of hands at work, no serious error could arise from the use of an expense percentage fixed on the preceding year's totals. With a notable fall or rise in the number of hands at work, however, such a percentage might give largely misleading results. But, having the last year's expense total in hand, it is always a simple matter to find an approximation to correct present expense percentage based on the number of hands now at work.

An order received in the office at Newton's is transmitted to the drawing room in regular course, where it receives an order card as given below—size $2\frac{3}{4}$ inches $\times$ $4\frac{5}{8}$ inches.

ORDER CARD.	
Date.....189	Sets.....Symbol....
For.....	
To be Shipped.....	
Drawings.....	
Notes.....	

(ORDER SENT OUT.)		
Deliver no goods Without Bill (numbered as ordered).		
Send statement of account first of each month.		
Foundry Order No.....	Philadelphia,.....18.....	
FROM NEWTON MACHINE TOOL WORKS,		
Twenty-fourth and Wood Streets.		
To.....		
Please make Castings from patterns below mentioned. Castings to be sound and free from blow-holes, cold shots, and all imperfections. Iron to be of good quality, and soft enough to work easily. All work done on imperfect castings will be charged to the Foundry.		
No of pieces.	Pattern mark.	REMARKS.
Price, per lb.....		
To be delivered.....		
Patterns to be returned to us, when desired, free of expense, and in good condition; and stored, while in your possession, free of expense. No allowance for cartage.		

STUB RETAINED IN STUB-BOOK.

NEWTON MACHINE TOOL WORKS.

Foundry Order No

Philadelphia.....

18.....

To.....

No. of Pieces.	Pattern Mark.	Patterns Returned.	Weight.	REMARKS.

Price, per lb.....

To be delivered.....

The drawing-room orders castings on blanks from a stub-book, printed on one side only, of the form given above. The size of the order sent out is $7\frac{1}{4}$ inches $\times$ 7 inches ; the size of the stub retained in the book is $8\frac{1}{2}$ inches $\times$ 7 inches.

This nominally settles the castings order. Those who are familiar with purchasing machine castings probably can tell, from their own experience, how near the assumption usually is to the fact in this matter.

From the order stub-book, a blank printed as below is furnished to the foreman in whose department the order falls. The size of this order is $6\frac{3}{4}$ inches $\times$ $10\frac{1}{2}$ inches.

(TO FOREMAN.)

NEWTON MACHINE TOOL WORKS.

Order No.....

Date.....

Filled.....

Ordered by.....

To be marked and shipped to.....

To be shipped via.....

Date to be shipped

Our order No.....

Name of Machine:

This machine to have the following special features, specified in their order :

The office transcript preserved in the stub-book is 9 inches $\times$ $10\frac{1}{2}$ inches, and is printed in the form given opposite.

(1) NEWTON MACHINE TOOL WORKS.		Cut off when bill is made out.
Order No.....	Date	Filled.....
Ordered by.....	Their Order No Their Req. No..... Our Shop No Our Bill No Date to be shipped Weight of Machine.....lbs.	
To be marked and shipped to.....	Terms Net Price	
To be shipped via.....	Discount	
Price.....		
Name of Machine :		
This machine to have the following special features, specified in their order:		
		Cut off when order is filled.

Large and small orders may follow each other. When two stub-books, one for large orders and one for small, are used, the order stub-book pages are printed on both sides, large order on one side, small order on the other ; either large or small order blanks bearing the same consecutive number, thus appearing in regular sequence in the stub-book. The large orders receive a charge-sheet in the charge-sheet-pad (to be hereafter described), while the small orders carry their time-sheet with them, and do not appear in any subsequent record, the stub record transcript alone being sufficient for

SMALL ORDER—KEPT WITH WORK AND RETURNED TO OFFICE WITH WORK COLLECTING TWO TICKETS.				
NEWTON MACHINE TOOL WORKS.				
Order No.....	Date.....	Filled.....		
Please do the following work. When finished, return this slip to foreman. Keep strict account of all time and material used. A piece-work ticket must be given with all work.				
NAME	Date	No. of Hours	No. of Lbs.	MATERIAL

reference. The large orders are carried on, and made a matter of record finally in the shop cost-books.

The foreman keeps the small order until the work is done, when it is returned (filled) to the office with the work, and is transcribed on its stub on the office order-book. The size is 6¾ inches × 10½ inches, printed as shown on page 613.

The stub-book small order blank is 9 inches × 10½ inches, printed as below :

OFFICE TRANSCRIPT.

NEWTON MACHINE TOOL WORKS.

Order No.

Date.....

Filled.....

Piece-work Ticket No.....

Price.....

Time.....

NAME	Date	No. of Hours	No. of Lbs.	MATERIAL.

This makes a very convenient method of obtaining both large and small blanks, as required, from one stub-book ; not only is it an office convenience, but it avoids the liability of oversight. As there is but one order-book kept, there is no possibility of overlooking a small order.

When a large order is sent into the shop, a “charge sheet” correspondingly numbered is placed on the charge-sheet tablet, where it is secured by a clip at the top, so that access can be had to any of the charge sheets, and where it is kept until the order is completed. This charge sheet is 11¾ inches × 18 inches, and the right-hand column contains a list of the machine-shop tools and the occupation of the non-tool-using workmen. The sheet is ruled in red in 36 columns for hour-charges, with the tool and trade list at the left, and a 1-inch margin at the right, and is printed as shown on page 615.

This charge-sheet receives a daily transcript of the time-taker’s sheet, which is a very peculiar affair, a distinct drawing-room emanation ; while differing entirely from anything previously brought to the writer’s notice, it seems to furnish an accurate time record with a very small amount of labor.

NEWTON MACHINE TOOL WORKS.

Shop No. Name Black Figures for Journeymen
 Red " " Apprentice Boys

Date 189

NUMBER OF MACHINES BEING BUILT

Forge.....	.....
".....	
72" Planer.....	7.....
42" Planer.....	1.....
".....	
36" Planer.....	2.....
".....	
32" Planer.....	3.....
".....	
24" Planer.....	4-5.....
".....	
20" Planer.....	6.....
".....	
36" Lathe.....	10.....
".....	
32" Lathe.....	32.....
26" Lathe.....	12.....
".....	
Pulley Lathe.....	41.....
24" Lathe.....	11.....
".....	
21" Lathe.....	21.....
20" Lathe.....	14.....
18" ".....	15-16.....
16" ".....	17.....
16" ".....	.....
Nut Facer.....	.....
12" Lathe.....	22.....
Boring Mills.....	8-9.....
Hor. Floor B. M.....	50.....
Boring Machine.....	36.....
".....	
10" Shaper... ..	37.....
Slotter.....	38.....
Cutting-off Machine... ..	39.....
Gear Cutter.....	26.....
12" Gear Cutter.....	51.....
Vertical Universal M.....	24.....
Milling Machine.....	28.....
Worm Wheel Cutter... ..	25.....
Drill Press.....	31.....
Plain Mill. Mach.....	40.....
Machinists Floor Hands F. H... ..	.....
".....	
".....	
".....	
".....	
".....	
Laborers.....	L.....
".....	
".....	
Pattern Makers.....	23.....
Painters.....	P.....
Boxing & Skidding.. B. S.....	.....

NEWTON MACHINE TOOL WORKS.				
Name		Shop Name.....		
Date of Order.....		Date of Shipment.....		
Number of Machines Built.....				
	Lbs.	@	Per lb.	
Cast Iron.....				
Brass.....				
Forgings made outside.....				
Forgings.....				
Wrought Iron ..				
Machinery Steel.....				
Machinery Steel....				
Cold Rolled Shafting.....				
Tool Steel.....				
Key Steel.....				
Forged Bolts, Nuts, etc ..				
Steel Castings.....				
Pulleys ..				
	Hrs.	@	Per hr.	
72" Planer.....				
42" Planer.....				
36" Planer.....				
32" Planer.....				
24" Planer.....				
20' Planer.....				
32" Lathe ..				
36" Lathe.....				
26" Lathe.....				
24" Lathe ..				
20" Lathe ..				
18" Lathe.....				
16" Lathe.....				
14" Lathe.....				
12" Lathe.....				
Slotters.....				
Boring Machines.....				
Boring Mills ..				
Pulley Lathe.....				
Shapers ..				
Cutting-off Machines.....				
Gear Cutting ..				
Milling Machines ..				
Vertical Milling Machines ..				
Tools not mentioned ..				
Hor. Floor Bor. Mach.....				
12" Gear Cutter ..				
Erecting ..				
Laborers ..				
Painting ..				
Skidding or Boxing ..				
Lumber used in skidding or boxing, and other material.....				
Sundry Bills, etc ..				
Drawings ..				
Patterns made outside.....				
Patterns made at shop.....				
Repairs made on patterns.....				
Traveling Expense ..				
Cartage ..				
Total Cost of Machine				
Sold for				



THE NEWTON TIME-SHEET BOARD.

line. Time is taken very rapidly with this odd arrangement, 58 names in one department being taken in less than 45 minutes. After the time-sheet is filled and removed from the board, it becomes a cryptogram, translatable only by being replaced on the time taker's board and read with the aid of the indexed T-square blade. Time charges are transferred from the time sheets to the charge sheet, until the job is completed. Then all the charges against the job are transferred to a loose, or "dummy," cost-book sheet, and, after this is made correct in pencil, it is transferred—in ink of course—to the fac-simile pages of the locked cost-book, and becomes one of the secret records of the house. The size of the double cost-book sheet is 23 inches horizontally $\times$ 18 inches vertically. The printing is given in full, the size being reduced.

It will be seen that the cost book footings show every detail of the cost, with total cost and selling price in the lower left-hand corner of the double sheet.

Every machine, as finished by the Newton works, has its cost sheet complete in the locked cost books, and an estimate for a new machine materially differing from anything previously manufactured can be readily made from such a record, as the same elements appear throughout the whole line of Newton machines with surprising frequency.

The labor pay at the Newton shops is made on the Halsey premium system, previously mentioned in connection with the Builder's Iron Foundry, of Providence, R. I. This system is highly spoken of by the Newton management, its workings being considered eminently satisfactory.

THE HIGH-SPEED STEAM YACHT AS A FACTOR IN TORPEDO-BOAT DESIGN. I.

By W. P. Stephens.

THE development of yachting within the decade now nearing its end has been marked by many notable features, but the most conspicuous, at least to the general public, is the great increase of expenditure. The improvements in technical details, important as they are, have attracted less attention outside of yachting circles than the heavy and steadily-increasing cost, both of construction and maintenance, of the pleasure fleet, in its two divisions,—sail as well as steam. In view of the cost of such a yacht as *Defender*, whose use was limited to less than a dozen races, and of the later steam yachts, such as the *Mayflower*, *Nahma*, *Varuna*, and *Margarita*, it is natural to ask what benefits are derived by a nation at large from this expensive and luxurious sport.

It has already been the pleasure of the writer to lay before the readers of *THE ENGINEERING MAGAZINE* the claims of yachting, considered solely as a sport, to public consideration and support as an important adjunct to the sea-power of a nation.* Though indirect, the influences of a national system of yachting are both positive and powerful in fostering in times of peace a love of the sea and a pride in maritime supremacy that is of the highest value in case of war. This is especially the case in the United States, with a vast inland population to which the sea, the warship, and the torpedo, with their terrible menace to the whole nation in default of adequate protection, are but abstract conceptions. If nothing more could be urged in behalf of what some may look upon as a useless and expensive amusement, there would still be good reason for the generous support of yachting by the government and the people; but there are various direct and tangible benefits that appeal no less strongly.

In the emergency now confronting the nation, the United States has been found unprepared in several ways,—particularly in seamen to man the vessels and in one of the leading elements of a modern war fleet, the torpedo division, consisting of torpedo boats and torpedo-boat destroyers.

The new naval militia of the different States has placed at the service of the country a number of men, young, enthusiastic, patri-

* "National Supremacy on the Sea." *ENGINEERING MAGAZINE*, October, 1895.

otic, and of unlimited ambition to excel in naval work. Conceding that none, save a few of the older men, have seen actual service, and that many are still but landsmen, and placing the very lowest value on this corps as but raw material, it must still be admitted that it is the very best kind of raw material, and such as can be had from no other source. That there is to-day a naval militia is due solely to the American yachtsmen, with whom it originated and who to a great extent make up its actual membership.

In the matter of boats, the yacht fleet has been called upon, with excellent results from an emergency standpoint, as one of the very few available sources of supply. Within a little more than a month a mosquito fleet that promises to be formidable and effective has been created by the purchase and hasty conversion of some twenty of the largest and finest American steam yachts. The conditions which have called this fleet into being are peculiar, and, it is to be hoped, exceptional. While the torpedo boat and the destroyer have had for some years almost the first place in the naval programmes of even the smaller nations, like Japan, they have received so little attention in America that the bulk of her small fleet is still on the stocks, or even on paper, instead of in commission. With an extensive coast line to patrol, a valuable fleet of armed cruisers and battleships to protect from the threatened attack of the Spanish torpedo fleet, and the demand for many armed vessels of very light draft for the shoal harbors of the Cuban coast, the opening of hostilities found the United States with but eight torpedo boats in commission, and no torpedo-boat destroyers. While even the best of the converted yachts are inferior in many essentials to the torpedo vessels, at the same time they are of immediate practical value as scouts and patrol boats off the seaport cities, and for the Cuban service.

The question of the direct value of the steam-yacht fleet in case of war is one that has for several years engaged the attention of yachtsmen and the naval authorities, a paper on this subject, accompanied by a very interesting discussion, marking the inaugural meeting of the Society of Naval Architects and Marine Engineers in 1893. Thus far, however, it has not progressed beyond the stage of theory and speculation, and the opinions of the experts are by no means unanimous.

The consideration of cost must always be a controlling one in a naval programme; no matter how wealthy a nation may be, or how liberal its naval estimates, it must still get the most for its money. With much in common between the steam yacht and the naval despatch boat or torpedo-boat destroyer, the requirements of pleasure, nevertheless, are widely different from those of war; and a very large

proportion of the cost of the yacht goes into special appointments and elaborate furnishings that are worse than useless in case of conversion to war uses. Taking this into consideration, it seems that the best results, both as to cost and ultimate utility, are to be obtained by the direct construction of an adequate number of war vessels for the torpedo fleet, rather than by the proposed plan of coöperation between the government and the yacht owners, the former exercising a certain supervision over yachts during construction, and having the use of them for a portion of each year, and the privilege of purchase in case of need.

In the present case it may be said that the emergency is such as to bar the question of cost; if the converted yachts accomplish the work expected of them, the very great expense of their purchase at high prices, their hasty conversion, and the destruction of a large amount of costly furnishings, will be fully justified. We may look in the immediate future for some positive evidence *pro* or *con* on this question, but, even though it be decided against this use of the pleasure fleet, there is still another direction in which the steam yacht may be of practical utility in naval development.

The advances of the last few years have been largely in the department of torpedo warfare, and, in particular, in the important detail of the new type of torpedo-boat destroyer, as described in the preceding issue of THE ENGINEERING MAGAZINE. Important as have been the improvements in the hull design of large war vessels, in machinery, armament, and armor construction, still greater progress has been made in the perfection of the torpedo boat and the development of the torpedo-boat destroyer. In each of these types speed is the principal factor, the first sought of several essentials; and the search for high and still higher speeds gains new vigor with each advance. It is in this field of experimental research in high speed work that the steam yacht promises to be a most useful auxiliary to naval progress in the future, as it has already been in the past.

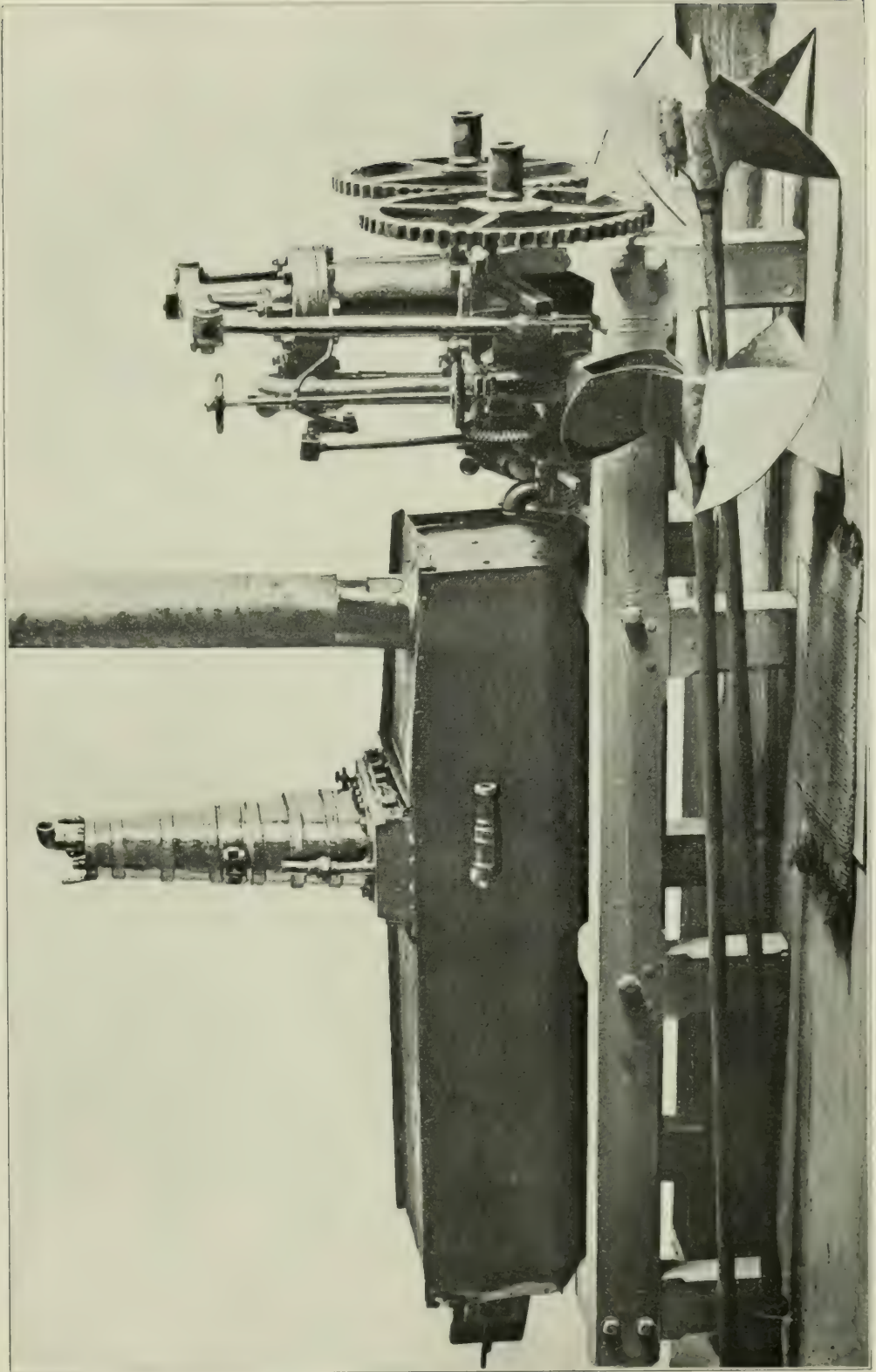
The position of the United States in relation to torpedo warfare is a very peculiar one. The torpedo and the torpedo boat are both of American origin, at least to the extent that the first successful experimental work was done in this country—by Fulton and others; both were first put to successful practical use in our civil war; and many important improvements have been made by Americans. At the same time, while the European nations have built up great fleets of torpedo vessels within the past twenty years, the government of the United States, up to five years ago, had done nothing, and even now is far behind the smaller foreign powers. In 1890, the year in which the first American torpedo boat, the Cushing, was placed in commission,

France possessed 210 torpedo boats, England 206, Italy 152, Russia 143, Germany 125, Spain 15, and even Japan had 24. At the beginning of the present year the United States had in commission eight torpedo boats and no destroyers, with twelve torpedo boats and three destroyers under construction. Since then two torpedo boats, the *Morris* and *Gwin*, have been completed.

The first suggestion of the high-speed yacht and the torpedo boat is to be found as far back as the date of the successful application of steam to navigation, at the beginning of this century. In the course of his extensive experiments in steam navigation, covering a period of nearly twenty years from about 1790, Col. John Stevens, of Hoboken, N. J., devoted much time and study to the screw propeller. Between the years 1801 and 1806 he experimented with a steam launch of his own design, running her on the Hudson river. The leading ideas of this craft not only were novel then among the many primitive experiments in steam navigation with paddles, oars, and the duck foot blade, but embodied the principles recognized in the engineering practice of this end of the century, though nearly half a century elapsed between the original experiments of Col. Stevens and the general acceptance of his ideas by marine engineers. Briefly stated, they are:

- (1) The direct-connected engine, with high piston speed;
- (2) The use of high pressure steam;
- (3) The multitubular boiler;
- (4) The short four-bladed propeller;
- (5) The use of twin-screws.

The progress which naturally would have resulted from the development of these advanced ideas was obstructed by the backward state of the arts at that time. The exportation of machinery from England was then prohibited by law, and this country boasted neither shops, skilled workmen, or even the crude machine tools then in use in England. The impossibility of constructing suitable engines caused Col. Stevens to abandon all efforts on the lines above indicated, and to confine himself to the slow-moving paddle engine, with steam of but two or three pounds above the atmospheric pressure. For nearly forty years after the first era of crude experiment, when the ocean steamship and the river steamer were commercial and mechanical successes, they depended on the box or shell boiler with steam of very low pressure, the slowly-moving engines indirectly connected to the shafts, and the paddle wheel instead of the screw. Col. Stevens and his descendants have been active agents in the cause of marine engineering down to to-day; but the immediate line of development on which the first real progress was made was very different from that indicated by this experimental launch. The first steam launch of which



ORIGINAL TWIN-SCREW ENGINE, BOILER AND PROPELLERS OF COL. JOHN STEVENS.
Built in Hoboken, New Jersey, in 1804.

there is any record in America, and presumably the first built, was the Sweetheart, designed by Mr. Charles H. Haswell, of New York, and built under his direction, at the Brooklyn navy yard, in 1837. She was 35 feet over all, 4 feet 3 inches beam, 3 feet depth of hold. Her engine was a miniature of the ordinary walking-beam type, then in general use and still familiar on ferry-boats, the cylinder being 4 inches diameter and 12 inches stroke, taking steam from a horizontal fire-tube boiler. The two paddle wheels were 3 feet 6 inches in diameter. The boat made a speed of $5\frac{1}{2}$ miles on the Hudson and East rivers.

For many years after this experiment nothing was done in the same direction. During the civil war some steam launches of crude and primitive build were used by the navy, some even carrying a spar projecting twenty feet or more forward of the bow, attached to which was a torpedo. The hulls were merely those of the rowing cutters and pinnaces of the day, and the engines were apparently very inefficient, as the ordinary rowing boats, propelled by oars, were fitted with spars and used with the steam launches. After the war no effort was made to improve the navy launch or to produce an efficient torpedo boat, though early in the seventies it was proposed to build some small vessels of especially light construction and high power from which a speed of 15 knots might be realized, fitting them for torpedo work. One of the first to achieve a notable success in the line of steam launches was the firm of John I. Thornycroft & Co., of Chiswick, England, which in 1870 launched the steam launch Ariel. This craft was built of bessemer steel, with plates $\frac{1}{4}$ of an inch thick, her dimensions being 45 feet 6 inches over all, 45 feet lwl, 5 feet 6 inches beam, 3 feet 3 inches depth of hold, and 2 feet draft. Her engines had two inclined cylinders, $5\frac{1}{2}$ by 6 inches, making over 400 revolutions. The rudder was in two parts, the shaft passing through it, with the screw well astern of the vessel. Mr. Thornycroft made only the modest claim of 14 miles, but even this was accepted with marked skepticism. After experimenting with another launch, the Swallow, in June, 1871, the firm made an indelible mark in the history of the steam launch by the launching of the Miranda. This craft was 50 feet over all, 45 feet 6 inches lwl, 6 feet 6 inches extreme beam, 5 feet $9\frac{1}{2}$ inches beam at lwl, 1 foot 9 inches extreme draft, and 2 feet 6 inches draft at heel of shoe. The displacement was 3.72 tons; the hull, plated with $\frac{1}{8}$ to $\frac{1}{4}$ -inch steel, weighed 1.10 tons, while the machinery, with steam up, weighed 2.05 tons. The two cylinders were 6 by 8 inches, and the boiler, of the locomotive type, was 6 feet long and 2 feet 8 inches in diameter, with steam at 100 to 125 pounds. Mr. Thornycroft's promise of 18 miles was more than realized in the ex-



THE STILETTO, BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.

haustive trials made by Sir Frederick Bramwell in 1872, when a speed of 16.1 knots was made, with 555 revolutions and 55 i. h. p.

This achievement led, in 1873, to an order from the Norwegian government for the first veritable torpedo boat, with a guaranteed speed of 16 statute miles in an hour's continuous run. The *Rasp*, as she was named, was 57 feet over all, 7 feet 6 inches beam, 3 feet draft, and about 7.50 tons displacement, with compound surface condensing engines of 90 i. h. p., a locomotive boiler, and the Thornycroft wheel. Forward and aft of the machinery space were open cockpits, with movable hatches of thin steel, while forward of the boiler was a steering compartment with a low conning tower of steel, with a protection of $\frac{3}{16}$ -inch steel plates over the machinery. With an average of 85 pounds' pressure, the *Rasp* made 17.22 miles in a run of one hour on the Thames.

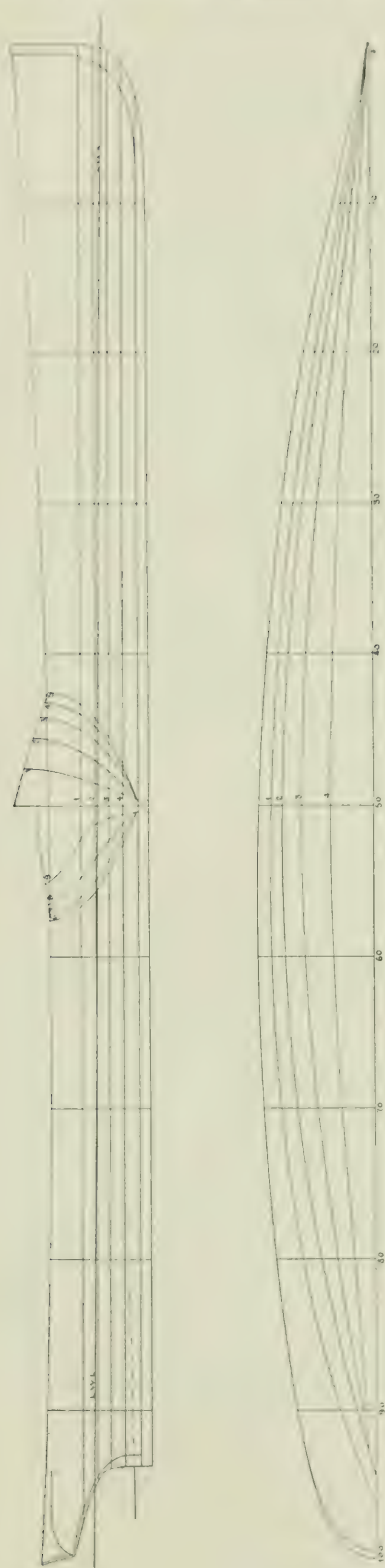
After this successful venture on the part of Norway, Sweden and Denmark followed with similar orders; then Austria, France, Holland, and Italy; but not until 1877 did the British government place its first order—for the *Lightning*, 84 feet over all, 81 feet lwl, 10 feet 10 inches beam, and 5 feet draft, showing 19.4 knots when light, on her preliminary trial. In the *Rasp* and the succeeding boats the torpedo was towed astern, and so steered as to sheer clear of the boat when launched against a hostile vessel.

Important as were the experiments with the *Miranda* and the first torpedo boats, they seem to have had little influence on the service launch of the British navy, which, up to 1879, was fitted with the ordinary high-pressure non-condensing engine. After that date came the surface condenser, compound engine, and forced draft.

In the United States the first steam yachts and small launches were introduced about 1870. The American yacht list of 1874 enumerates 22 steamers, from the *Ideal*, 130 feet over all, 110 feet lwl, built in 1873, down to small open launches, none built prior to 1869. The Herreshoff Brothers, of Bristol,—later the Herreshoff Manufacturing Co.,—were among the first builders of successful launches, their work, even at that early day, being marked by that originality of design and lightness of construction which was the distinguishing feature of *Defender*. From the first they paid little attention to the conventional methods of hull construction and the reduced fac-similes of large engines which made the ordinary steam launch of the time a slow, heavy, and clumsy affair, but worked after direct and original methods for the main ends in view—lightness and speed. They turned out launches for yachtsmen and also for the navy, and small steam yachts; and in 1876 they built for the United States government its first torpedo boat. The *Lightning* was an open wooden launch, 58 feet long, fitted with spar torpedoes, and showing about 17 miles on her trials. Nothing more was done by the United States, but in 1878 an order was received at Bristol from the British government for its second torpedo boat. This craft departed widely from the ordinary launch type in model, and possessed some remarkable features. She was 59 feet 6 inches long, 7 feet 6 inches beam, with a wooden frame and $\frac{7}{8}$ -inch white cedar planking up to the water-line. Above this the skin was of steel, up to the gunwale, with a crowned deck of steel extending down to the gunwale, the general appearance being similar to *Stiletto*, page 627. The compound engine had cylinders 6 and $10\frac{1}{2}$ inches by 10 inches. In accordance with a theory then in favor,—that the best position for the wheel was well under the hull,—the wheel was below the keel at a distance of about two-thirds of the length from the bow. The shaft was allowed to take a natural sag from the engine, placed well forward, curving down through the keel to the propeller. Outside the hull it was carried in a hollow keel or fin built of two plates of brass, with sufficient space between for the shaft and bearings. The constant strain due to the twisting of the shaft with every revolution caused it to break frequently.

By this time, 1878, the importance of the torpedo boat as one of the essential implements of modern warfare was recognized throughout Europe, and under the active encouragement of all the continental powers such men as Thornycroft, Yarrow, and Normand were raising the record of speed, with added fighting efficiency, at each fresh attempt. On the other side of the Atlantic, however, the torpedo boat received no attention from the government after the first feeble effort in the *Lightning*. Fortunately, however, there were private individu-

als who were sufficiently interested in the subject of high speed to

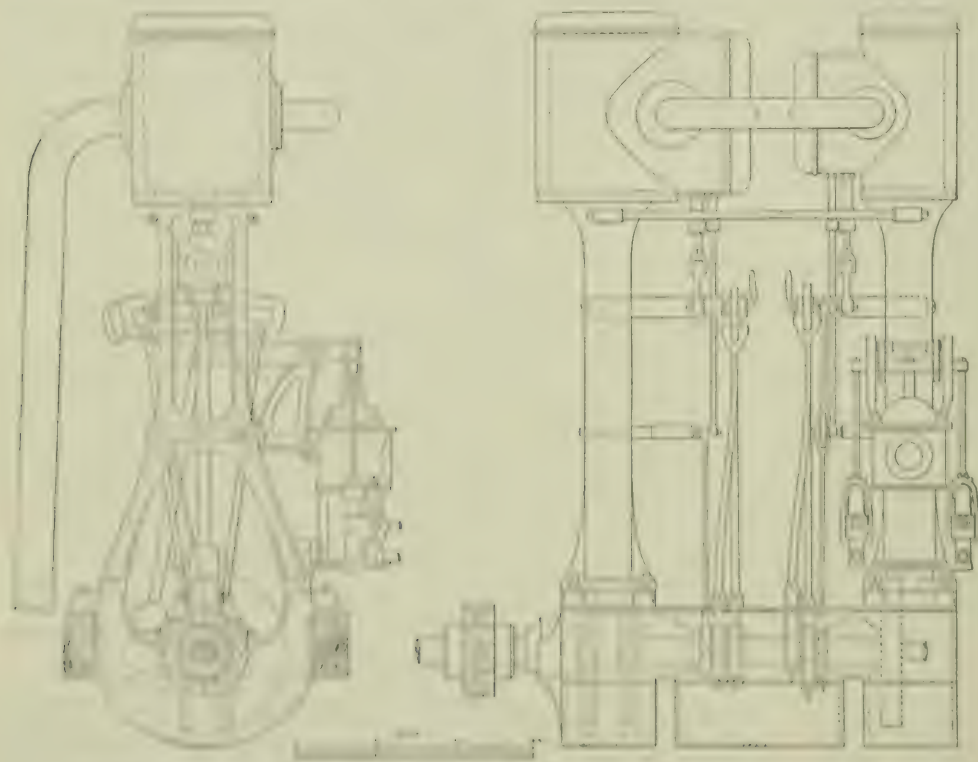


THE LINES OF THE LEILA.

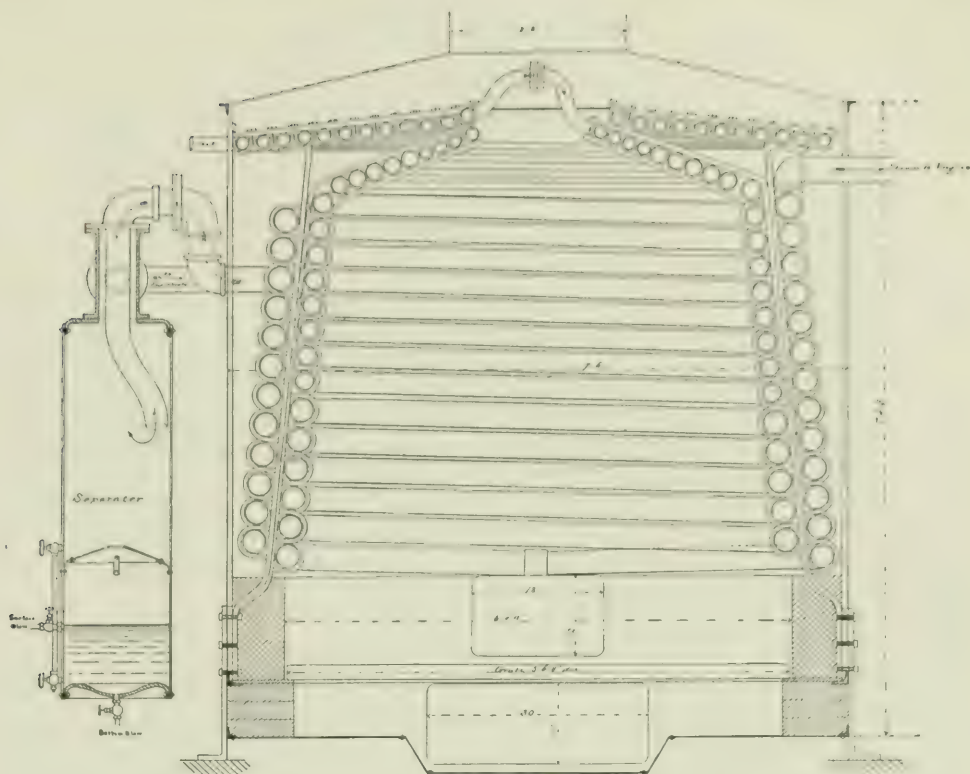
offer the necessary encouragement to designers and builders; and in 1878 one of these, Mr. W. H. Graham, of Baltimore, placed with the Herreshoffs an order for a high-speed steam yacht. This yacht, the *Leila*, was 100 feet over all, 95 feet 5 inches lwl, 15 feet 4-inches beam at deck, 11 feet 9 inches beam at lwl, 5 feet 6 inches depth of hold, and 4 feet draft. The hull was of wood, with the exception of angle iron frames, the planking being of yellow pine sheathed with copper. The angle irons were $1\frac{1}{2}$ by $2\frac{1}{4}$ inches, spaced 15 inches, with planking $1\frac{1}{4}$ and deck $1\frac{3}{8}$ inches. The compound engine had cylinders 9 and 16 inches by 18 inches, with a four-bladed screw of 4 feet 7 inches diameter and 8 feet pitch. The boiler was of the Herreshoff double-coil type, 7 feet in diameter and 8 feet high. The *Leila* was the subject of exhaustive experiments by three naval engineers in 1880, who reported very favorably as to the model, construction, engines, and, in particular, the coil boiler.

In 1880 the Herreshoffs turned out a larger yacht for Mr. Graham, the *Gleam*, of 120 feet over all, 110 feet lwl, 16 feet beam, and 5 feet 8 inches draft, with similar engines, enlarged to $10\frac{1}{2}$ and 18 inches by 18 inches, and a boiler 5 by 8 feet, of 192 h. p. This vessel also proved successful. These were followed by many steam yachts, pleasure launches, and naval launches for the United States and foreign governments, all marked by lightness of construction

and speeds suitable to the intended use. In 1884 they built a 35-foot launch, of 7 feet 6 inches beam, with compound engines of 50 h. p., for the steam yacht *Atalanta*, the little boat showing a speed of $12\frac{1}{2}$ knots. The following year the firm turned out, to its own account, one of its most notable successes, the steam yacht *Stiletto*, 94 feet over all, 90 feet lwl, 11 feet 4 inches beam, 8 feet depth of hold, and 4 feet 6 inches draft, with a displacement of 28 tons. Like the English torpedo boat already mentioned, the model showed a marked departure from the conventional steam yacht and in the direction of the modern torpedo boat, the deck having a strong reverse sheer and being joined to the hull proper by inclined sides. The two-cylinder compound engines were 12 and 21 inches by 12 inches, with annular valves cutting off at about $\frac{5}{8}$ of the stroke, with about 450 revolutions. The boiler was of the Herreshoff coil type, 7 feet square, with 615 square feet of heating surface, the working pressure being 160 pounds and the h. p. 450. The hull was of wood, with oak keel, stem, and sternpost, light bent frames of oak spaced closely together, and a double skin of white cedar and pine. The wales were of oak, heavy, and moulded from the solid. The entire hull was light, the upper works and deck especially so. The hull was divided into six water-tight compartments. Very little was heard of the yacht during



ENGINE OF STEAM YACHT "*LEILA*," HERRESHOFF MFG. CO., BRISTOL, R. I.



COIL BOILER OF THE "LEILA," HERRESHOFF MFG. CO., BRISTOL, R. I.

her construction, but in June, 1885, she made a sudden *début* in New York waters in an impromptu race against the famous Hudson river steamer, Mary Powell, for so many years the recognized standard of speed on the river. Though entirely unofficial, and not timed, this trial demonstrated the speed of the new craft; and it was verified in the following month, in the second annual regatta of the American Yacht Club. In this race the course was from off Larchmont down Long Island sound to New London, a distance of 80 nautical miles, the fleet of starters numbering sixteen, the largest being the big cruising yacht Atalanta, of 228 feet lwl, a vessel specially designed for speed in her class. The Stiletto covered the course in 4 hours, 49 minutes, and 54 seconds, an average speed of 16.5 knots, beating the Atalanta by 4 minutes 4 seconds. She was used by her builders until 1888, when she was purchased by the government and attached to the Newport torpedo station as a practice boat, in which service she remains.

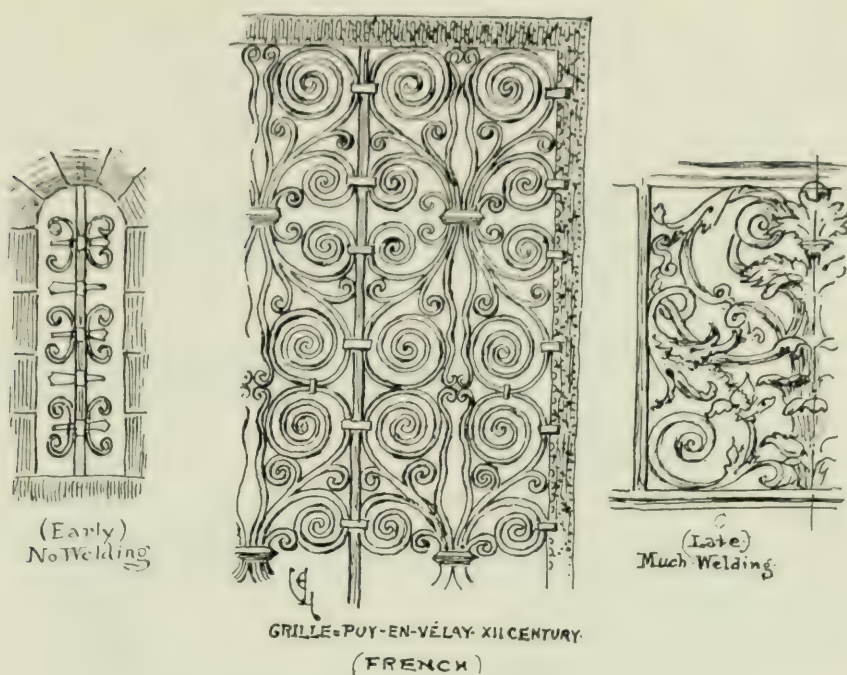
ARCHITECTURAL WROUGHT-IRON ORNAMENT.

By W. Martin Aiken.

IRON has been known and used for about five thousand years. Tubal Cain, son of Lamech and Zillah (only seven generations from Adam), was "the instructor of every artificer in iron and brass." The British Museum contains a piece of iron from an inner masonry joint in the Pyramid of Cheops, the oldest known edifice built by the hand of man. In early history the power and skill of the blacksmith was deified in the person of Hephaistos by the Greeks, or of Vulcan by the Romans, and volcanoes were supposed to mark the spot below which, in the nether world, he worked at his forge in shaping the thunderbolts of Jove or the armor of Mars. Dr. Schliemann, in his excavations at Mycenae and Troy, found numerous specimens of wrought iron, some of which may now be seen in the museum at Athens: Greek painted vases show anvils, hammers, pincers, and bellows; and welding is said to have been invented by Glaucos, of Chios, 600 B. C.

In the Kirchlerian Museum, Rome, and National Museum, Naples, are many examples of Roman iron work used as arms, utensils, and house-furnishings. Iron rings among Romans were insignia of freemen, and, though weapons and articles for use were of iron, those for ornament were generally of bronze or brass. Ordinary labor was performed by the slave, skilled labor by the freeman. Things of artistic finish were hardly ever of iron; consequently the very early iron work of museums can not compare in subtlety of design or nicety of execution with bronze, brass, or ceramics of the same period.

The Gauls of the northern provinces were well acquainted with the use of iron, though they were interrupted in its development by the invasions of the fifth and sixth centuries. Among them it was diverted to warlike uses rather than to the arts of peace. Eastern and western conquests and commerce with Syria, Persia, and India, as well as the Crusades, brought to light many hitherto unknown uses of this metal. In those days, when every man's hand was against his neighbor, and when "might made right," there were grilles at the windows and bars at the doors. The windows at first were small, and very seldom was glass used in them, the substitute (if any) being cloth or the skins of beasts. The opening was protected by parallel or interlacing bars, or, later, by some pattern of scroll work or inter-



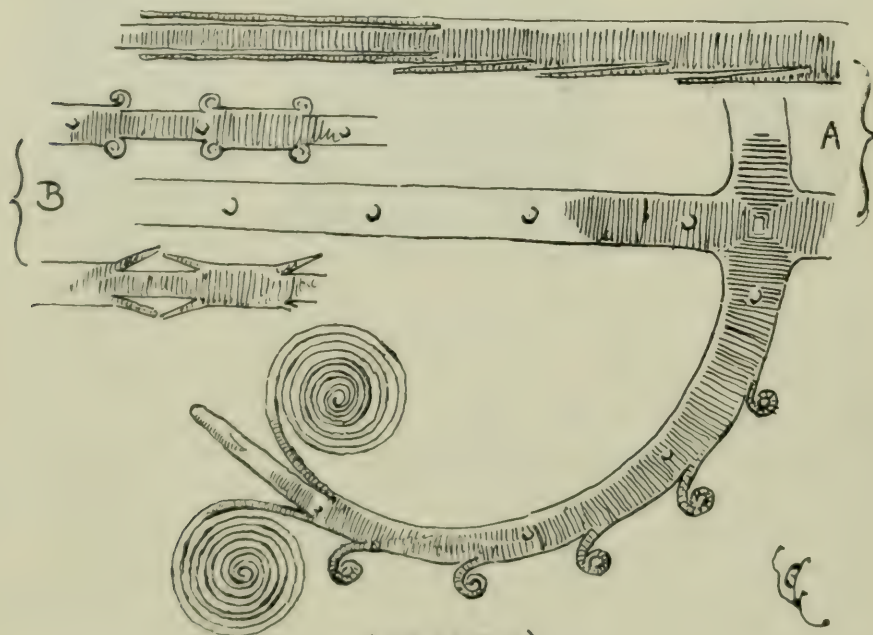
twining branches of wrought iron. Afterwards, when men began to build larger and better houses, balconies were constructed from windows of upper stories, and, where the sun was hot, there were rings or sockets for holding the frames of awnings.

In the midst of this perpetual warfare, sometimes as a result of it, a church would be built, and upon it the best labor would be expended, with the choicest materials to be found. As early as the tenth century a beautiful rood screen was made for the cathedral of Auxerre, in France, which was described in the chronicles of the monks of the time as being "of marvelous delicate workmanship."

In the twelfth and thirteenth centuries the blacksmith who could fashion an elaborate hinge was accounted the master of his trade, as in Venice was the bricklayer who could build successfully the fantastic chimney-tops of that city. At that time bar and sheet iron were not to be found already manufactured, and the use of the file was not known; but the paucity of materials and tools brought about great skill in the use of the hammer, and, as, with the gradual introduction of mechanical appliances, many difficulties, especially of large or intricate pieces, were overcome, by degrees manual dexterity declined. The working in iron possesses in common with painting and sculpture the charm of proceeding directly from the hand of the originator; the personal element is pronounced.

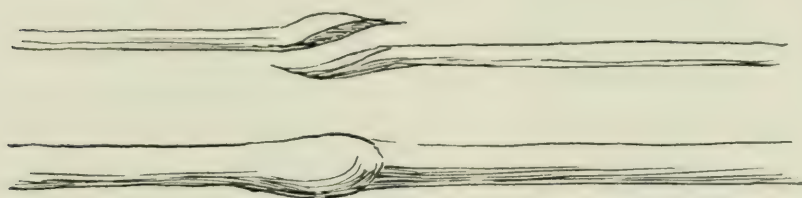
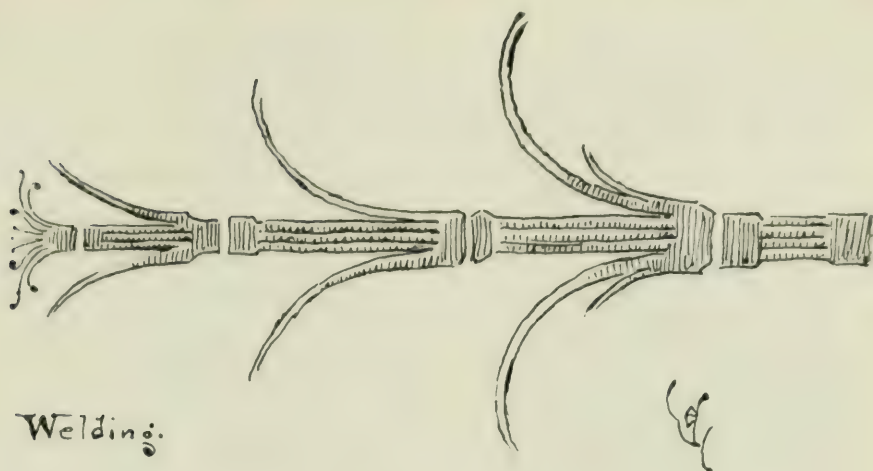
Doors were first made of hewn timber of single thickness (with battens), or of two or more thicknesses, and, as every house-holder

was liable to be attacked at some time, the hinges performed the double duty of revolving the door and of strengthening it. The early forms of hinge were: (1) the shoe (into which the upper and lower inner angles of the door were fitted) and the pintle, which were housed into sill and lintel; (2) the double strap (passing across each face of the door, forming a loop at the inner edge) and the gudgeon, secured in the jamb, over which the strap fitted. Later, in Germany



(FRENCH)
ROMANESQUE

and northern France, the single strap, on one face only, was used, and in central and southern France the C shape; gradually the shapes were combined and others were introduced, a favorite type being the horizontal stem with curving scroll-like branches in France and with angular branches in Germany. The vine or the acanthus generally supplied the motive for this work; but in the thirteenth century certain independent characteristics began to appear in German work, some with very elaborate branching strapwork, ending in vines or fleurs de lys,—derived, but differing, from the French,—as seen in Magdeburg, Marburg, and elsewhere. Among the best known and most decorative of this period in France are the hinges on the *Porte Ste. Anne* (to right of centre on west front), of *Notre Dame*, Paris, which were considered so wonderful that it was said by some that the maker had bartered his soul to the devil in the making of them, and by others that he was the devil himself. If there

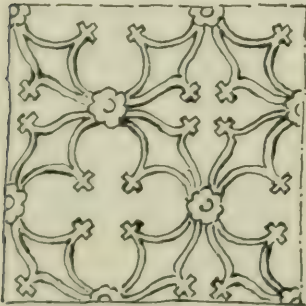


(FRENCH)

are those who consider that too many curvilinear forms in wrought iron indicate a weakness, lack of virility, or inconsistency of design with material, and that the decorative arts have a stronger claim to our respect when their beauty proceeds from their fitness ; to them it may be said that the blacksmiths of Auvergne seem to have felt this, since they have used more angular and robust forms among the curves.

Towards the end of the fourteenth century, Germany excelled in wrought-iron work, which was peculiar in being "repoussé" and so thin as to resemble sheet iron, often taking certain forms based on the thistle, and frequently secured to the wood over skins or heavy cloth, and generally painted red. This was not used in France until the fifteenth century. With the disappearance of the tongued and grooved woodwork of mediæval doors, the long strap hinge and the other decorative stiffening bands gave place to the butt hinge used on the framed and panelled joinery of the Renaissance. The employment of iron work has always been intimately connected with and fostered by architecture ; so, when one architectural style was replaced by another, the fashion of iron work was likewise affected. These results were by no means the same in different countries. In Italy, for instance, where Gothic principles were neither understood or appreciated,

•FLORENCE•



PERUGIA



VENICE



•ITALIAN RENAISSANCE•

wrought-iron work did not show the same sympathy with the Gothic style that was shown in France or Germany, while its wrought-iron work of the Renaissance showed certain peculiarities of marked and very diverse character. The grilles at the entrance of St. Mark's, Venice, were of cast bronze of a Byzantine scale pattern, and were the source of inspiration for many other grilles; but, when they were imitated in wrought iron, much labor was saved by turning up the ends of the scales (making scrolls of them) and forming almost endless combinations by placing them at many different angles next each other. Many Italian grilles are based upon the quatrefoil and these scrolls, small or large, play an important part in the Renaissance as in the earlier work. A balcony in the Palazzo Bevilacqua, Bologna, is a beautiful example of the continuous use of the small scroll; the grilles surrounding



•FRENCH GOTHIC•

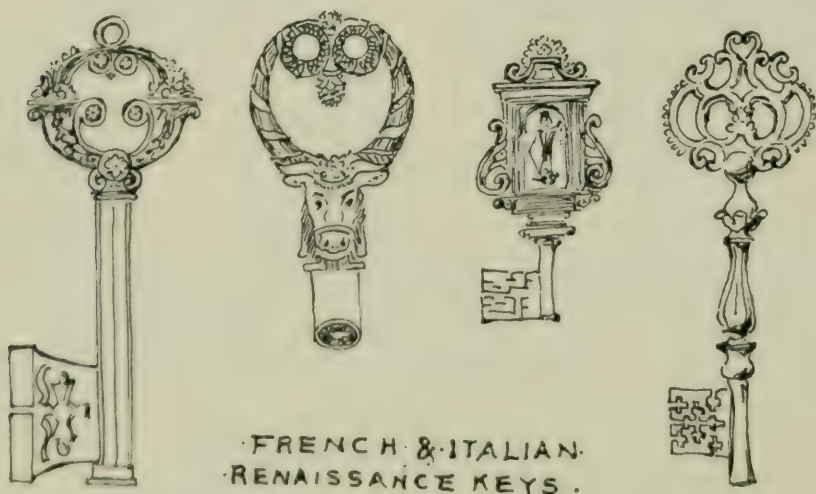


the tombs of the Scaligeri (with the ladder in each quatrefoil) in Verona (1375), and certain others in Siena, Florence, Prato, and Perugia, show the application of the quatrefoil. Many churches in Venice contain lamps hanging from the ceiling by chains of great delicacy and variety of design, and there are myriads of bridges and balconies and fan-lights throughout the city. In Siena and Florence are several cressets, or torch-holders, and banner-holders, beautifully modelled and very skilfully wrought. Of door-knockers there are many Italian examples. An antique found at Capua is the head of Medusa; a later one from Ferrara is David with the head of Goliath, surrounded by two lions. Lions, lion's head (with ring), dolphin, and the human head, or figure, were favorite subjects.

It is rather surprising that, from an age when so much of this character of work was done, no drawings of iron work have come down to us, especially when so many for gold, silver, and bronze, have been preserved. The influence of Vitruvius on Italian architecture was a serious blow to architectural wrought iron; but there were no remains

of iron work existing in Rome, and not until Palladian architecture had become somewhat degenerated did the window grilles, which had been of square or round bars set in rectangular or lozenge shape, begin gradually to curve outwards, and then to assume other fanciful forms. Little architectural work save wall anchors, finials, door trimmings, and kitchen utensils, was made under the earlier Renaissance, although arms and armor were fashioned more beautifully than ever.

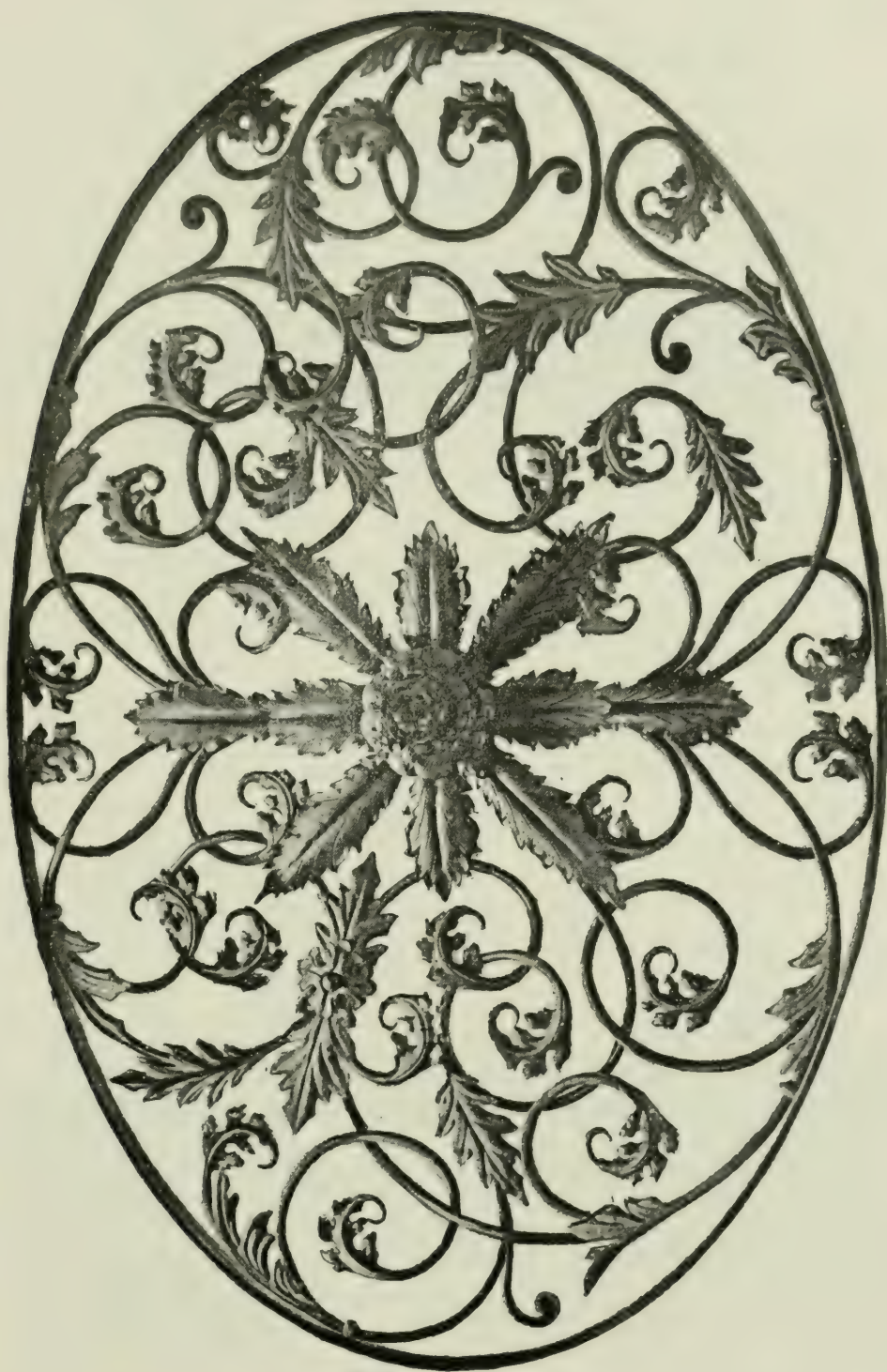
In Austria there may not be so many notable examples as in Germany, France, northern Italy, or Spain, but among them are a few which are remarkable, such as the grille surrounding the cenotaph of the Emperor Maximilian at Innsbruck, which possesses some of the peculiarities of the work of southern Germany,—large and frequent scrolls, many turns, little leafage, mostly round iron, bars passed through each other, and not welded, diagonal rods passing through scrolls. An excellent example of this “threaded” work is seen in a balcony from Nuremburg. Very little early work remains in Belgium; the wealth of the country caused it to disappear under the fre-



FRENCH & ITALIAN.
RENAISSANCE KEYS.



GERMAN LOCKS.



OVAL GRILLE. THE YALE & TOWNE MFG. CO.
Note the balance of masses without identity of the two sides.

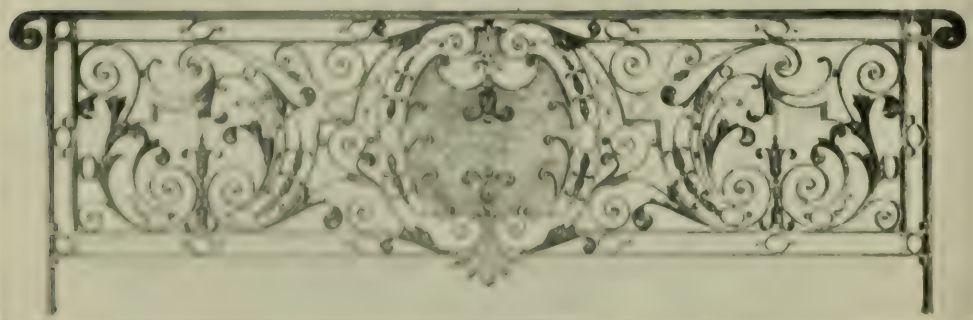


HAND FORGED FINIAL. JOHN WILLIAMS.

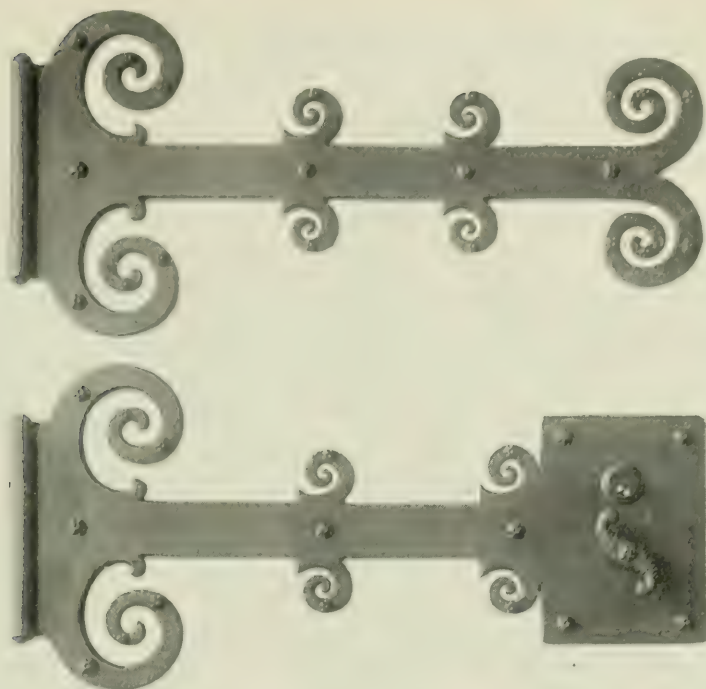
quent demolition and rebuilding of the time. Only Bruges and Brussels possess many interesting examples. The reproduction of the forms of fruit, flowers, and garlands was brought to great degree of perfection in after years. The Matsys family, of Louvain, gave to wrought-iron work very great distinction, and the well-cover at Antwerp (1470) is worthy of high praise.

Spain first introduced Flemish grilles for its churches in the sixteenth century, when that country was rejoicing in great commercial prosperity. The Queja (as the choir screen was called) was often more than thirty feet in height, and was formed of rods, some of them twisted, and of long, attenuated balusters, arranged in panels surmounted by a deep frieze of leaf work and ending in very rich crestings, consisting of armorial bearings, figures, and scrolls. Great taste and refinement were shown, and much splendor was obtained by frequent gilding.

The plant forms were often borrowed from those of the new world,



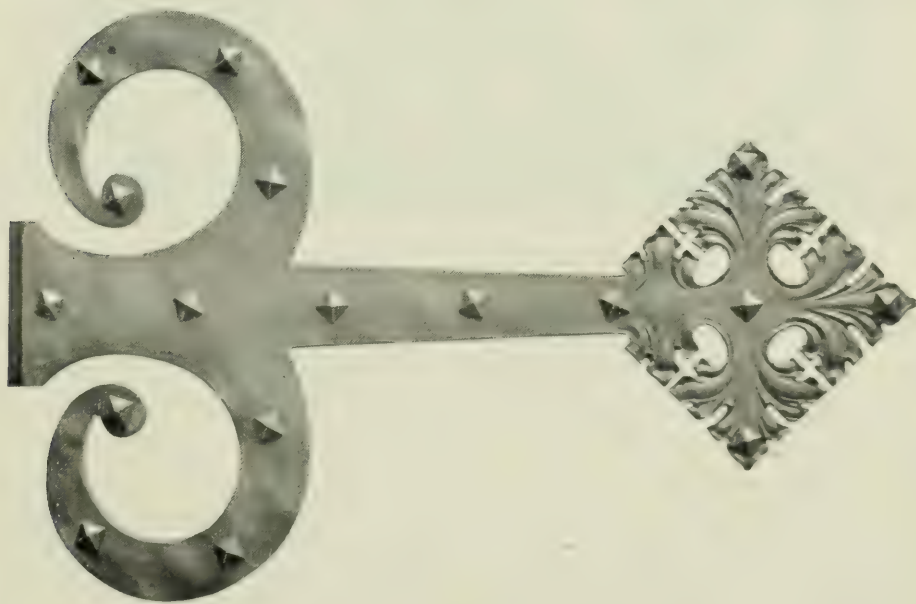
HAND FORGED RAILING. DESIGNED BY RUTAN & RUSSELL; EXECUTED BY WINSLOW BROS.



ROMANESQUE HINGE STRAPS. THE YALE & TOWNE MFG. CO.

such as the aloe, agave, and yucca. No countries so abound with wrought-iron grilles, fences, and gates, at the present day, as Spain and Portugal, where frequently vineyards are closed by gates of excellent design and workmanship.

In England wrought iron was as well developed in the tenth cen-

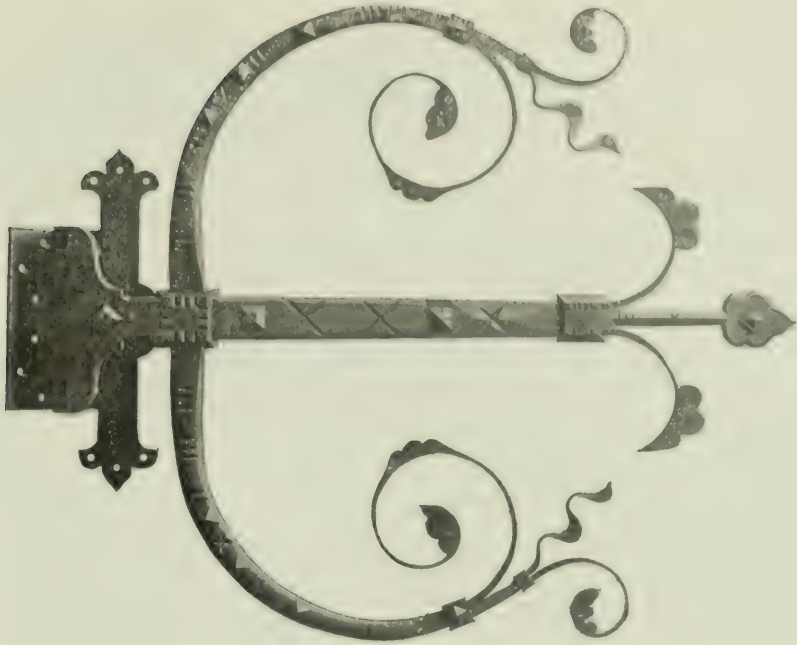


GOTHIC HINGE STRAP. THE YALE & TOWNE MFG. CO.



HAND FORGED PANEL. JOHN WILLIAMS.

tury as at any period up to the thirteenth century. The crescent form of hinge is to be found on doors of the old churches of Kent, Yorkshire, Essex, Norfolk, and Suffolk. A very considerable proportion of the surface of many of these early doors was covered by iron work, which had much of the thickness of metal of the French, with the angular branching and quadrated leafage of the German work, and the habit of placing a scarlet lining between the wood and iron, which existed as early as the tenth century, antedates the German. Grilles in English churches may almost be counted on the fingers of the two hands, but tomb rails were very numerous in church interiors down to



GOTHIC HINGE STRAP. THE YALE & TOWNE MFG. CO.

about the middle of the seventeenth century. After the fifteenth century the work became uninteresting and not very good. The collection in the South Kensington Museum, while containing much interesting material, is extremely meagre in English examples.

In the middle ages the trade of the blacksmith was raised so near to the highest point of art-smithing that, with the coming of the Renaissance, much of the clumsiness and angularity of the Gothic disappeared, and, instead, a simplicity and refinement appeared, to give

such beauty of form as has never before been seen. The casting of iron began to be known at this time, though its use was comparatively limited. At this time also the balustrade was developed architecturally ; independent iron gates were not used commonly until the time of the Renaissance. The screw, for securing hardware in place, had been in use only since the end of the fifteenth century, although the industry of hardware was well developed in France,



WROUGHT IRON ANDIRONS, WINSLOW BROS. Switzerland, Bohemia, Bavaria,

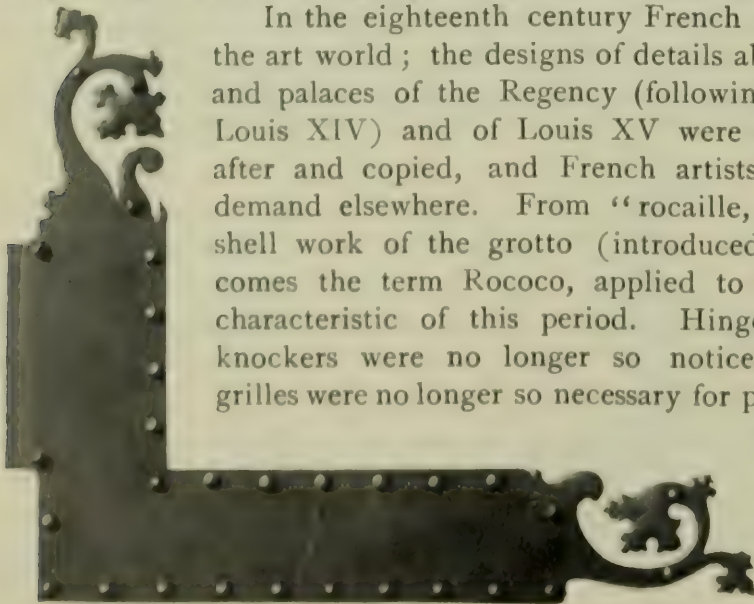
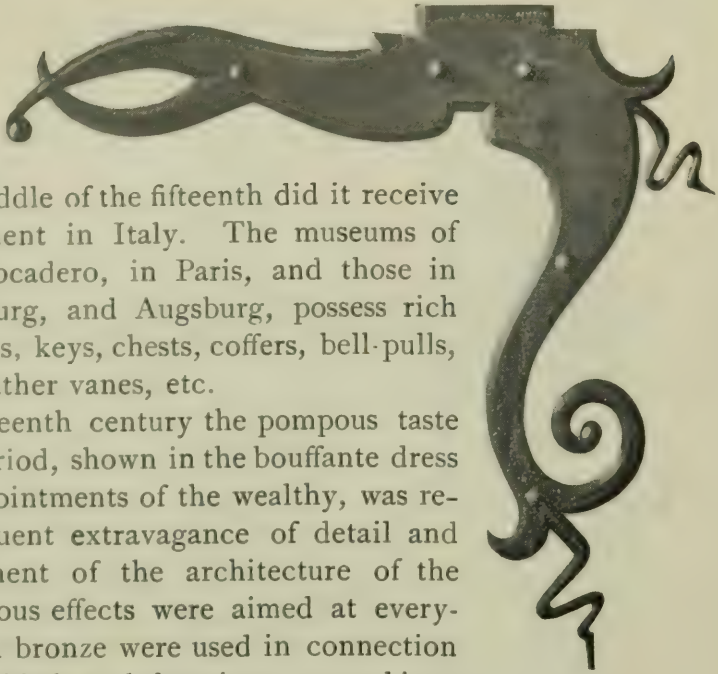
and along the borders of the Rhine in the fourteenth century,—not, how-

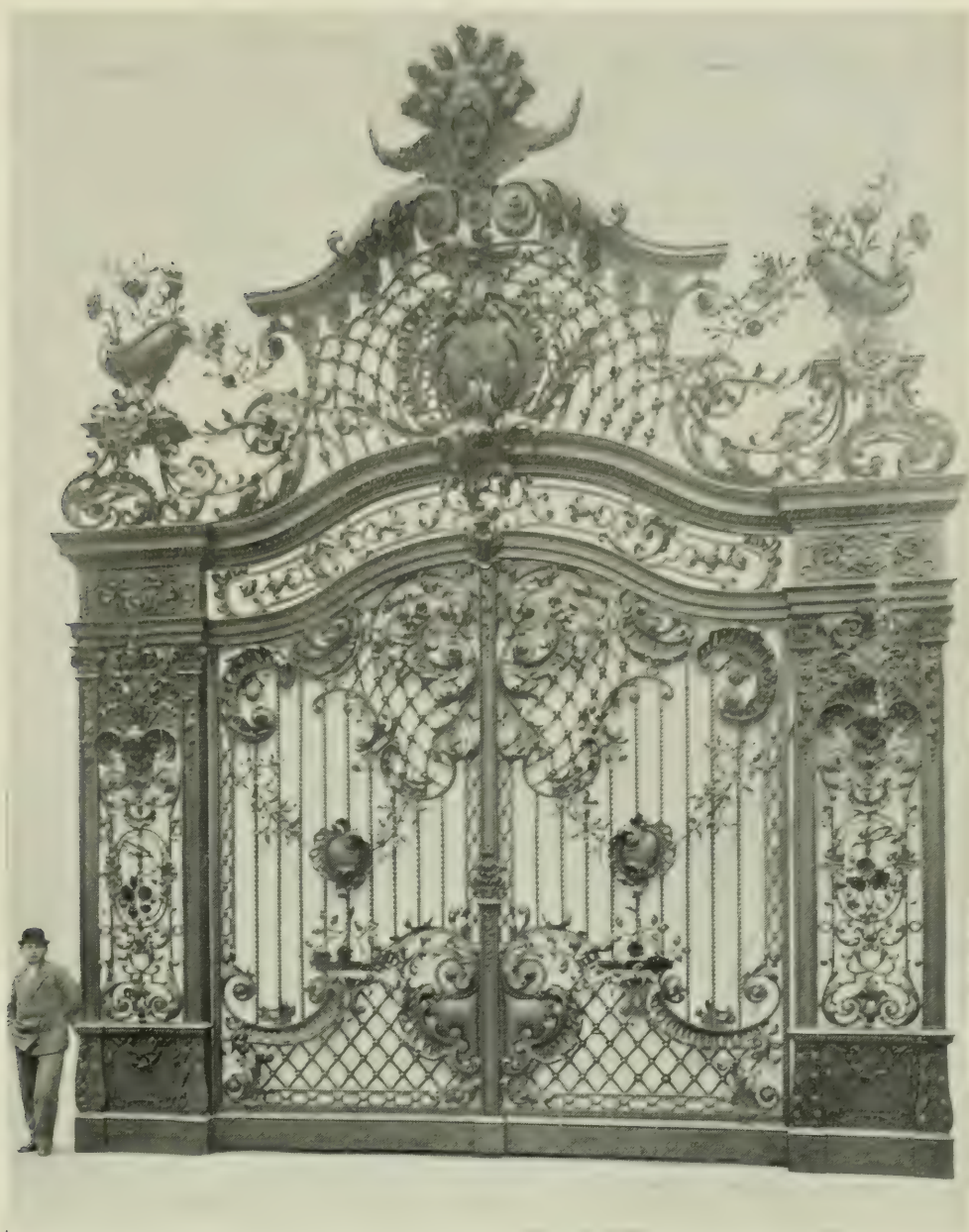
ever, until the middle of the fifteenth did it receive much encouragement in Italy. The museums of Cluny and the Trocadero, in Paris, and those in Munich, Nuremburg, and Augsburg, possess rich collections of locks, keys, chests, coffers, bell-pulls, sign brackets, weather vanes, etc.

In the seventeenth century the pompous taste of the Baroque period, shown in the bouffante dress and luxurious appointments of the wealthy, was reflected in the frequent extravagance of detail and overloaded ornament of the architecture of the time, and sumptuous effects were aimed at everywhere. Brass and bronze were used in connection with wrought, moulded, and sheet iron ; round iron gave place to square ; leaves, volutes, rosettes, garlands, cartouches, initials, and coats of arms were freely used. Grilles required sometimes more than half a dozen sections of bar iron ; rich effects were concentrated at prominent points, the field often being filled with parallel bars or lattice work ; pediments, panels, and pilasters (with cap and base) were skilfully reproduced and used on a large scale in and about the chateaux and churches frequented by the princes of the period, this style being especially affected by the Jesuit churches.

In the eighteenth century French taste regulated the art world ; the designs of details about the castles and palaces of the Regency (following the death of Louis XIV) and of Louis XV were eagerly sought after and copied, and French artists were in great demand elsewhere. From "rocaille," the rock and shell work of the grotto (introduced from Italy), comes the term Rococo, applied to the decoration characteristic of this period. Hinges, locks, and knockers were no longer so noticeable ; window grilles were no longer so necessary for protection ; but

sign-brackets, balcony-railings, and balustrades were more gener-

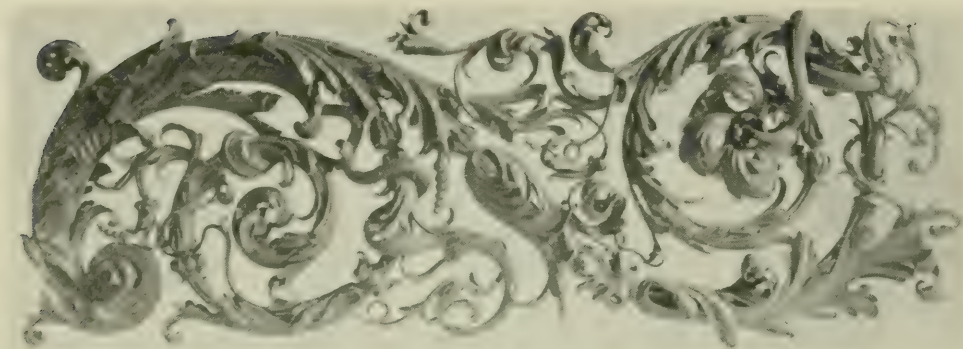




WROUGHT DRIVEWAY GATE. WINSLOW BROS.

ally used than ever, and parks, both large and small, were handsomely railed in, and provided with magnificent gates.

In the early part of the present century ornamental iron work received its first substantial recognition in America in the frequency of lamp standards, entrance railings, and balconies in the best houses in the eastern cities, and in the grilles, gates, and balconies of those in the south, which showed traces in New Orleans of French and Spanish influence, and in Charleston of English influence.



WROUGHT IRON PANEL. WINSLOW BROS.
From original in Entrance Gates, Maisons-sur-Seine.

For fifty years there has been but little wrought iron used, until recently; but in the meantime the gamut has been run in cast-iron from the rustic border of the flower-bed, the deer on the grass plot, and the lion at the door of the suburban cottage, to the five-storied warehouse, more than two hundred feet square, which, on its completion (about 1874) was the best-known dry goods house in



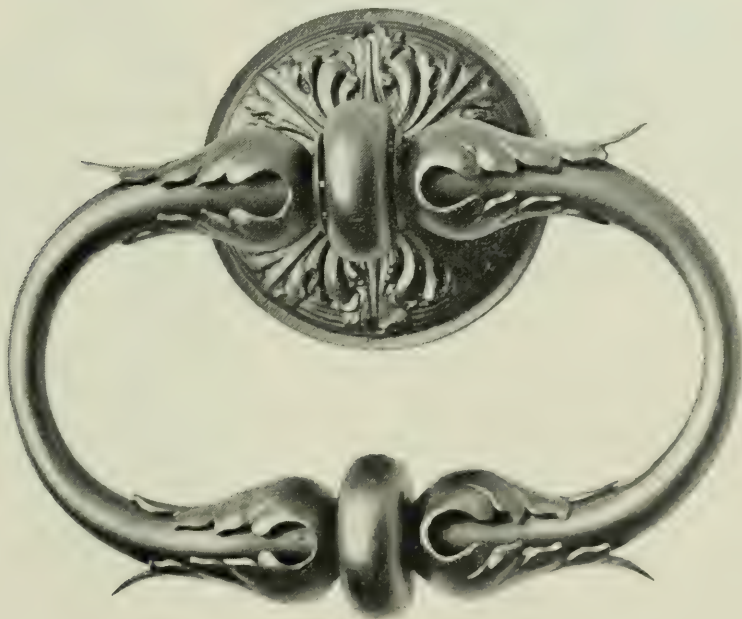
ENTRANCE GATES. WINSLOW BROS.



SEMI-CIRCULAR GRILLE. THE YALE & TOWNE MFG. CO.

America. Since the great fires of Chicago and Boston, and between the time of the Philadelphia Exhibition in 1876 and that of Chicago in 1893, there has been very great improvement in both cast and wrought iron.

Much of this improvement was due to the general and increased prosperity of the country, to the foreign training of the architects, and the patience, ingenuity, and skill of the workmen. To such men as the late H. H. Richardson and the late R. M. Hunt, America is indebted for the introduction and evolution of many beautiful designs, and to Messrs. John Williams and A. B. Stillman, of New York, and Winslow Bros., of Chicago, specially in wrought iron, and Yale & Towne, in cast-iron and bronze hardware, for the execution of work that will rank worthily with much of the best in foreign lands. Mr.



FORGED KNOCKER. THE YALE & TOWNE MFG. CO.



WROUGHT IRON ELECTROLIER. WINSLOW
BROS.

stone balustrades to the steps and balconies of many New York houses has given an opportunity for renewing them, and the demand for greater elegance at the principal entrance has led to the removal of the outer vestibule doors, the replacing of which has produced some very interesting work.

In the Metropolitan Museum is a valuable collection of excellent

Richardson's hinges of Trinity Church, Boston, of Sever Hall, Cambridge, and of his various libraries, and the grilles of four residences in Washington; Mr. Hunt's Havemeyer fence and gates on Madison avenue, New York, and the grille at the entrance of the W. K. Vanderbilt house at Newport, with the multitude of their balconies, railings, and lamp standards, are known and admired all over the country.

The gradual decay of brown-



WROUGHT LAMP. JOHN WILLIAMS.

examples of European work, presented by Mr. Henry Marquand.

Oxidation is the omnipresent and irresistible enemy of iron-work, and many devices have been employed to overcome it. Gilding has been often used to excellent advantage, but, on account of its expense, can never become general. The Bower-Barff process is also used for hardware and small pieces, but has its limitations. Painting is the most universal form of protection, but with successive applications the density of the pigment, used to give body and color to the oil or other vehicle, certainly detracts from the beauty of finely wrought surfaces and edges.

There has never been written a full and complete history of iron work, giving its contemporaneous development in all countries;

but, as the subject has always been an interesting one, there are many *brochures*, encyclopædic articles, and folios prepared at different times and in various lands. The following are among the most important publications, though, besides these there are countless illustrations of iron work intermingled with the drawings and sketches of architectural publications.

Handbook of Art Smithing	<i>Franz Sales Meyer.</i>
Architectural Iron Work	<i>Wm. J. Fryer.</i>



WROUGHT LEAF GRILLE. WINSLOW BROS.

- Examples of Decorative Wrought Iron Work, seventeenth and
eighteenth centuries *D. J. Ebbetts.*
- Iron Work (South Kensington Handbook) *J. Starkie Gardner.*
- Transactions of Royal Inst. British Architects (1890-'91-'92)
J. Starkie Gardner.
- Smithing and Ironmongery *Gwilt's Encyclopædia.*
- Architectural Wrought Iron (plates) *W. W. Kent.*
- The Iron Age (weekly) Nos. from June 8th, to July 6th, 1893.
- "Grille," "Heurtoir," "Serrurerie" (Dictionnaire de
l'Architecture) *Viollet le Duc.*
- Many Articles in Dictionnaire du Mobilier. *Viollet le Duc.*
- Serrurerie (Dictionnaire d'Ameublement) *Henri Havard.*
- Serrurerie (Grammaire des Arts Decoratifs) *Charles Blanc.*
- Revue des Arts Decoratifs } Articles collated and }
L'Art pour Tous } bound together. } *Serials.*
- Motifs divers de Serrurerie } *César Daly.*
- Fidelle ouverture de l'Art de Serrurerie *Mathurin Jousse.*
- Serrurerie du Moyen Age *Raymond Bordeau*
- Modèles de Serrurerie, (Plates) *Leconte.*
- Modèles de Serrurerie " *Bury.*
- Les Arts du Metal " *Giraud.*
- Artistic Wrought-Iron Work " *Fonteyue.*
- Wrought-Iron Work in the Style of Louis XV. *François de Cuvillies.*
- Histoire du Luminaire *Henry René d'Allemagne.*
- Die Schmiedekunst.
- Alte Kunstschmiede-Arbeiten *Schubert.*
- Kunstschmiedeisen-Sammlung *Hapelmann.*
- Geschmiedete Gitter *Adalbert Roeper.*
- Deutsche Schmiede-Arbeiten *Adalbert Roeper.*
- Der Kunstschlosser im Styl des XVI., XVII., XVIII. Jahrh. *Moser.*
- Kunstschlosserei des XVI., XVII., XVIII. Jahrhunderts
Conradin Walther.
- Wiener Schmiedewerk des XVII., XVIII. Jahrh. *Dr. Albert Ilg.*
- Dresdner alte Schmiede-Arbeiten des Barock und Rococo
Richard Weisse.
- Wrought-Iron Work in Baroque and Rococo *F. Ehemann.*
- Modern Wrought-Iron Work *Franz Brechenmacher.*

REVIEW OF THE ENGINEERING PRESS

The Flow of Water in Pipes.

THE problem of the flow of water is one of such importance that every contribution to the stock of original data is to be welcomed, especially if the observations are made with such a degree of scientific precision as will enable their value to be "weighed" in comparison with others, and used to check the results of existing formulas and methods.

A paper presented before the American Society of Civil Engineers giving the results of experiments on the flow of water in the six-foot steel and wood pipe line of the Pioneer Electric Power Company, at Ogden, Utah, is a most valuable contribution to the subject of the flow of water in large pipes, and the authors, Charles D. Marx, Charles B. Wing, and Leander M. Hoskins, are to be congratulated upon both the work itself and the manner of its presentation.

The importance of the tests will appear when it is understood that, so far as known to the authors, no experiments upon the discharge of new riveted pipes of diameter as great as 6 feet have been made, and the experiments upon riveted pipes of smaller sizes have been too few to furnish a basis for establishing a law for the relations of velocity, diameter, and other conditions.

Two sets of experiments were made, one upon a riveted steel pipe, of mean diameter of 72.22 inches and a length of 4,367 feet; the other upon a wooden stave pipe, 72.5 inches diameter and 2,710 feet long; the difference of level between the two ends of the steel pipe being about 360 feet, and of the wooden pipe about 50 feet, the profile giving varying slopes in various portions.

The main object of the experiments was to determine the relation between the rate of discharge of the pipe and the loss of head between certain definite points. To accomplish this it was necessary to measure simultaneously the pressure at

each end of the length of pipe under experiment, and the rate of discharge.

The pressures were measured with mercury gauges, enabling a much higher degree of precision to be obtained than is possible with Bourdon gauges, while the discharges were determined by the use of Venturi meters, for which the necessary coefficients were furnished by the makers. As the rate of discharge was the measurement desired, and not the total volume, the automatic registers of the meters were not used, but instead there was attached to each meter a mercury gauge designed to show, at every instant, the difference between the pressures existing at the throat and the up-stream sections of the Venturi. This pressure difference indicates the rate of discharge instantly, and no time interval need be measured.

By taking observations simultaneously for a given length of time, and then causing the rate of flow to be changed and taking a fresh set of observations, repeatedly, a series of average results were obtained, which are tabulated and discussed at length in the original paper. For these details the reader must be referred to this original memoir, but some of the conclusions may be here recorded, especially in so far as they relate to the constants in certain well-known formulas.

Experiments at velocities ranging from 0.5 to 4 feet per second showed that it was inadvisable to use in the Chezy formula a value of "c" greater than 110, and, if the pipe is old, or there are frequent bends, the value should be still less. For the Kutter formula the usual value for "n" of 0.010, which is probably correct for pipes below 36 inches diameter, should be increased to 0.013 to 0.015 for the larger pipe; 0.013 being about right for the smooth wooden pipe. This appears to indicate that the Kutter formula is open to criticism for such large pipes, but additional evidence should be adduced before final judgment is passed in this respect.

Incandescent Lamp Efficiency.

THE term efficiency is used in connection with the performance of various devices without the real meaning of the term being always clearly understood, and this is especially the case with many electrical appliances.

A paper by Mr. Francis W. Willcox in the *Electrical World* discusses one phase of this subject in connection with the real meaning of incandescent lamp efficiency, and shows some of the elements which enter very largely into the efficient performance of incandescent lamps.

"Almost every one knows that the term efficiency is used to denote the power per unit of illumination consumed by the lamp at the beginning of its life, and that it is generally convenient to express it in watts per candle. For example, a 16-cp. lamp consuming a total of 50 watts is designated as having an efficiency of 3.1 watts per candle." This is the generally understood meaning of the term "efficiency," and forms the present basis of rating incandescent lamps. While this may answer for a sort of classification, it is not the true basis for determining the quality of the lamps, as it does not include the important element of the length of time at which a high efficiency is maintained.

After the early makers had overcome the difficulties of making lamps that will last, they endeavored to obtain the greatest amount of light with the least amount of power, while containing at the same time a fair average life. The result was the production of a lamp consuming at the start not exceeding 3.1 watts per candle, and, while such lamps gave a low average light during their life, they were hailed with great acclaim for the saving in power per lamp unit effected. In this way efficiency at starting, or initial efficiency, came to be accepted as a basis for determining the relative value of different lamps, the lamp having the highest efficiency (least watts per candle) with fair average life being judged the best lamp.

The present idea, however, is to give more attention to sustained candle power. "Were the efficiency of an incandescent

lamp, like that of a motor or a dynamo, a constant quantity, practically unchanged by duration of service, the initial efficiency rating would, for a given voltage and candle power of the lamp, be a proper measure of its value. Such, however, is not the case, since as a result of the loss of candle power while in service, a lamp's efficiency changes considerably, the watts per candle augmenting, as a rule, in direct proportion to the loss in candle power. A proper measure of lamp value should consider not only the lamp performance at starting, but its after performance as well, for a given period of life. Average efficiency conforms to this requirement, and becomes, therefore, a proper measure of lamp value and test of lamp quality."

By illustrating the decline in candle power, plotting curves of candle power, taken at 75 to 100-hour intervals, it is clearly shown that the initial candle power falls off 40 to 50 per cent. during 600 hours of service. A comparison of four lamps, all showing the same initial efficiency, reveals a marked difference in average efficiency, while at the beginning the poorest lamp appears as good as the best.

It is therefore evident that initial efficiency is really only a classification for lamps, and not a measure of their value, and that its use for the latter purpose is incorrect and misleading. The real measure of lamp value is average efficiency, which includes not only the starting conditions, but the actual performance in a given period of life as well.

Wrought-Iron Compression Tests.

SOME important tests of the behavior of wrought-iron cylinders under compression have recently been made by Prof. W. Kendrick Hatt in the engineering laboratory of Purdue University, and from a report in *Engineering News* we give some of the principal results.

The main object of the experiments was to determine the influence of the shape of the specimen on its ultimate strength in compression, the ratio of length to diameter at which bending begins, the limit of plasticity, and the ratio of compression at that limit; and to obtain information

which might aid in the definition of a standard test piece for compression tests of ductile metals.

The tests were made upon cylinders of soft Swedish iron, using various ratios of length to diameter, in order to determine, if possible, the best ratio for a standard test piece, the results being plotted in curves, enabling the behavior to be readily seen. When the ratio of length to the radius of gyration exceeded 30, the specimen failed by bending, while at smaller ratios the bending was accompanied by bulging. When the ratio fell below 10, the failure was mainly due to bulging, accompanied by the formation of longitudinal cracks, and occurred at a stress equal to the limit of plasticity, this being between 64,000 and 76,000 pounds per square inch for the different specimens tested. The compression of the specimens followed the law of compression of elastic fluid.

By the limit of plasticity is meant that point at which the stress per square inch of actual area of cross section ceases to increase with increase of load. At this point the cohesion of the material seems to be overcome, corresponding to the point at which a tension test piece necks in.

From an examination of the curves and the tabulated records of the tests Prof. Hatt deduces that a specimen whose length exceeds ten diameters will give a satisfactory determination of the yield point. The "crushing strength," which we should fix at the same point as the limit of plasticity for ductile metals, may be determined from a specimen of a length of less than two diameters.

Steam Engine Trials.

IN some lines of work it is undoubtedly most desirable that the investigator should be unhampered by set rules or hard-and-fast methods, and where original research is the principal object this is a consideration which should not be overlooked. In the case of comparative tests, however, which are constantly being made of such standard devices as engines and boilers, it is almost necessary that there should be some degree of uniformity of method and

record, if the results are to be of service to any one except the immediate observer; and even in his case much of the value of his work is lost, if the results cannot be readily compared with those of previous trials.

The importance of a standard method of conducting steam engine tests is clearly brought out by two papers presented at the recent convention of the American Society of Mechanical Engineers, at Niagara Falls, one by Mr. George H. Barrus, and the other by Mr. Bryan Donkin, and the result of the discussion which these papers elicited was the appointment of a committee to report at a future meeting of the society upon the subject.

Action of this sort has resulted in excellent work by committees of the society in kindred lines of work, and, as Mr. Barrus says, this has given the society a position in the engineering world which it would not have occupied had it followed a different policy. In the steam engineering line we now have a standard method of boiler testing, a standard method of conducting duty trials of pumping engines, and standard methods of testing locomotives; but we have thus far no standard which applies to the general subject of engine testing.

Mr. Donkin calls attention to the fact that the council of the Institution of Civil Engineers has taken the matter up and appointed a "Thermal Efficiencies Committee," which is shortly expected to issue its full report. A preliminary report of this committee was issued in the spring of 1897, giving some idea of the general view of the subject which might be expected to appear in the final report, and with this material in hand the American committee should have little difficulty in harmonizing its work with that of engineers in England. In this connection it is also interesting to note that the *Verein deutscher Ingenieure* is investigating the subject, and that its committee is in correspondence with the American society with a view of harmonizing methods.

Under these conditions it seems altogether probable that not only a standard method of conducting steam engine trials

will be devised by the American society, but also that the interest in the subject will result in the formulating of an international and uniform method of testing steam engines, which will enable the results obtained in America, England, or on the continent to be intelligently and promptly compared.

Both Mr. Donkin and Mr. Barrus suggest the desirability of classifying steam engines into groups or divisions, as it is manifestly impracticable to devise a standard method of testing which shall be adapted to all kinds of engines. It will be interesting to compare the two classifications, and it is probable that modifications in both will be found advisable in the end.

Mr. Donkin's suggestion is to group the subjects as :

Steam Boilers, Locomotive and Pumping Engines,

Marine and Factory Engines, etc.,

Rotary Engines,

Gas and Oil Motors.

Mr. Barrus divides the engines as follows :

Factory Engines, or engines employed in the production of power in general,

Pumping Engines,

Locomotives, (a) shop tests, (b) road tests,

Engines employed in generating electricity,

Marine Engines.

The suggestion of Mr. Donkin that gas and petroleum motors be included seemed to meet with favor with the society, as the committee was instructed to take that point into consideration in its deliberations.

Incidentally it is expected that the codes for testing steam boilers, locomotive engines, and pumping engines will be revised, and the whole subject unified and harmonized.

Mr. Barrus says: "The principal data required for an efficiency test of a steam engine are the weight of steam consumed, and the amount of power developed. These two elements of data are fundamental, whatever the type of engine and whatever the class of work performed. It is evident at the outset that a system of

engine testing applicable to all engines would be a method of determining these quantities. Consequently the proposed standard would relate primarily to these two things and to the expression of efficiency derived therefrom."

The Thermal Efficiencies Committee puts the matter rather differently, and says, in its preliminary report: "For all purposes, except those of a scientific nature, it is desirable to state the economy of a steam engine in terms of the thermal units required per indicated horse power per hour (or per minute), and that, if possible, the thermal units required per brake horse power should be also given."

This obviates the consideration of the varying number of thermal units in the feed water, which must be included when the number of pounds of water per horse power is stated, and makes the method applicable to engines using superheated as well as saturated steam. Doubtless these two aspects of the subjects will be well considered, and the ultimate result will be a simple and uniform code, which will benefit both the engine builder and the customer.

Sampling Pig Iron for Analysis.

ONE of the most important points in connection with the determination of the chemical composition of any material used in the arts is the selection of a fairly representative sample for analysis. This is well understood in the assay of ores, and in the tests of fuels and minerals in general, and is equally important in the case of pig iron analyses.

This subject, so far as it relates to pig iron, is very comprehensively discussed in a paper by Mr. Albert Ladd Colby, published in a recent issue of the *Iron Age*, and some of the points made will bear repetition and emphasis.

To a certain extent the chemist may be held responsible for work put upon carelessly selected samples. "A little tact and extra energy on the part of the chemist in showing by chemical analyses the want of homogeneity in the various materials regularly analyzed, and hence the necessity of expending considerable time

and money to obtain representative samples of them, would effect a marked improvement, for no intelligent manager will continue a practice which is apt to yield misleading results, when by the expenditure of a little more money he can obtain figures which can be relied on."

One of the oldest and most frequently used methods is that of taking drillings selected from the beds, but, as usually conducted, it is open to much criticism. If an insufficient number of pigs are sampled, very variable results are obtained, the greatest variations occurring in silicon, sulphur, and carbon. A tabulated list of analyses is given in the paper to show that in some cases much higher silicon is generally found in the iron coming first from the furnace, and that in others the middle and later beds showed the higher silicon, while analyses by the writer showed the variations to be greater than consistent with trustworthy results. Variations in composition also occur in different parts of the same pig, so that the selection of test samples in this manner is not to be recommended.

"A much better, as well as cheaper, method of sampling is to cast four small test ingots while filling the beds, taking the first ladleful when the first bed is almost cast, and casting the last ingot when beginning to fill what will probably be, as near as can be judged, the last bed cast. An equal measured quantity of fine drillings from each ingot form, when thoroughly mixed, an average sample of the cast."

"This method of sampling has many advantages over the selection of pigs from the beds of the cast. It gives as good an average as can be obtained by the selection of pigs from different beds, and at the same time furnishes small, clean samples, free from sand and segregation, and more conveniently drilled than pieces of pig iron."

Another method, highly recommended, is that of selecting samples by dipping small ladlefuls from the runner, at least four times during the casting. These ladlefuls are run into a bucket of water, from a height of about 4 feet, the bucket be-

ing covered with coarse wire gauze to scatter the stream. The result is a quantity of uniformly small shot, and by having the bucket divided into four partitions the shot is divided and an equal amount of shot from each will form a sample of the cast. This shot is pulverized in a special form of steel mortar, until all of the sample selected will pass through a 100-mesh sieve.

This method avoids the irregularities due to segregation and to the presence of imprisoned sand, and the only disadvantage which it involves is that the phosphorus cannot be accurately determined in white iron by Drown's rapid method by oxidation with permanganate. This is not a serious objection, as but a short time is required to evaporate the solution to dryness and convert the phosphorus into ortho-phosphate.

In sampling for the determination of graphitic carbon either a representative sample must be selected by examination of the average fracture of the broken pigs, or, if the cast is subdivided and piled according to grade, a pig representing the grade of each lot must be selected and the carbons estimated separately in each sample.

In sampling cars of pig iron received by the buyer a customer cannot justly claim from the analysis of a single pig taken from each car of iron received that the furnaceman has failed to keep within the chemical analysis agreed upon; and the same rule holds good for the furnaceman in maintaining his position. If a contract requires the shipment of an iron of a certain average analysis, the customer's sample of each car should consist of carefully-mixed fine drillings from at least four pigs. Especial care should be taken to secure homogeneity of samples when they are distributed among several chemists for comparative tests; otherwise injustice may be done, and doubts cast upon conscientious and accurate work.

An appeal is made to the Foundrymen's Association to adopt representative methods of sampling pig iron, and there seems to be reason for the adoption of this course to the benefit of all concerned.

Air Compressors at High Altitudes.

THE well-known law of barometric decrease in atmospheric pressure with increasing altitudes must be taken into account in considering the performance of air compressors, and, as very many compressors used in connection with mining operations are situated at high altitudes, the subject becomes one of practical importance.

A general discussion of the question is given in the *American Machinist*, by Mr. F. A. Halsey, and the effect of altitude upon capacity very clearly shown.

"It is a very common impression that the amount of compressed air produced is in proportion to the barometric pressure, and that the consumption of power for a given amount of air at a given gauge pressure is the same at all altitudes. Neither of these impressions is correct. The amount of air delivered at different altitudes decreases slower than the barometric pressure, while the power required to produce a given amount of air increases with the altitude. In other words, while the power required to operate a compressor of given size decreases as the altitude increases, it does not decrease as fast as the volume of air delivered."

By a comparison of indicator cards and a simple computation Mr. Halsey shows that the output of a given machine does not diminish as rapidly as does the barometric pressure, the assumption being that the air is delivered at the same pressure in both instances, but taken in in each case at the pressure corresponding to the elevation of the compressor.

A point which must not be overlooked is that the effort necessary to open valves and fill the cylinders is practically the same at all altitudes, and hence the relative importance of this resistance becomes greater as the altitude increases.

"The increased number of compressions necessary to produce a given gauge pressure at an elevation lends an added value to compound compressors in such locations. The clearance loss increases with the ratio of compression, and hence, for a given gauge pressure, is greater at high altitudes than at low. For example, six

compressions at the sea level with an initial cylinder pressure of 14 pounds will give a final gauge pressure of 69.25 pounds, while at 10,000 feet altitude the same number of compressions would give but 45.85 pounds gauge pressure, and so far as clearance losses are concerned there is just as much reason for compounding for 45.85 pounds at 10,000 feet as there is for 69.25 pounds at the sea level.

"Considering the reduced delivery of compressors at high altitudes, the increased cost of a machine for a given duty, and the increased power cost of a given amount of air, it is clear that a given percentage of loss is a more serious matter in such machines than in those located at the level of the sea, and that compounding is justifiable when its percentage of saving is less in the former case than in the latter. There can be no doubt that at the altitude at which many mining plants are located compound compressors should be used in all cases."

Mr. Halsey gives a very convenient table showing the relations between power, output, and pressure for various altitudes, thus enabling computations to be avoided in practical work, and permitting the results to be determined with a degree of precision quite within the limits of working requirements.

Testing Iron and Steel.

THE increasing attention which is being given to the investigation of the properties of materials of construction renders the valuable paper of Mr. Paul Kreuzpointner upon the subject of testing iron and steel, published in the *Journal of the Franklin Institute*, especially interesting at the present time.

As Mr. Kreuzpointner well says: "If we know much about the behaviour of iron and steel under strain, our methods of testing will be the proper ones, and we will thereby obtain, or buy, with that large amount of knowledge, a maximum of security, of safety, of reputation, of freedom from danger, anxiety, and worry, of financial and social success for the investor and engineer. On the contrary, if our knowledge in this line of pursuit is in-

ferior and defective, our methods of testing will be inferior and defective, and we can buy but a minimum of safety and success, with consequent loss through avoidable repairs, renewals, the use of more metal than necessary, or inferior metal, with all this implies."

In discussing the various methods, Mr. Kreuzpointner intimates that the value of the tensile test has been overrated to a considerable extent, although it is nevertheless a most valuable and indispensable guide. In many cases a bending or nicking test will show the internal make-up better than a tensile test of the same material, but at the same time the judgment of the individual and a knowledge of the methods of manufacture enter into the nicking test to a much greater extent than in the tensile test.

In a tensile test, the elastic limit, as indicated by the drop of the beam of the testing machine, is a point to which often much importance is attached. Engineers and their inspectors use this drop of the beam in commercial testing almost exclusively, and of course the mills do not object as long as the consumer is satisfied. To this method of taking the elastic limit, however, Mr. Kreuzpointner gives scant consideration, and, after discussing what really may be supposed to take place in molecular rearrangement when the elastic limit is reached, he shows that, even if the beam drops temporarily, the metal is weakened momentarily to such an extent that it cannot carry the load, there has been an entire and radical change of structure, and the engineer begins to deal with new and unknown qualities of the metal. The method of taking the elastic limit with the dividers, crude as it is, is more reliable for revealing the true condition of the metal under test than the drop of the beam, which not only gives too high a value, but also gives results contrary to accepted theories and practical experience. Still more reliable are some special instruments now in the market, which although they may not be perfect, are a great improvement over the data obtained by the drop of the beam.

Mr. Kreuzpointner also discusses in a

very clear manner the relative value of the drop test, and shows its true importance as a measure of shock-resisting power.

The quenching test as a measure of quality and practical utility may be considered of doubtful value. So many variables enter into the successful performance of this test that it is very easy to produce such conditions as will nullify the object which we intend to accomplish, and, as usually performed, it is a mere piece of guesswork, unjust to the manufacturer and misleading to the engineer.

There is much in this valuable paper which cannot be abstracted here, and the high standing and wide experience of the author should render all who have to do with the testing or using of iron and steel interested in the perusal of the entire paper.

The Cleveland Water Works.

THE location of many important cities on the shores of the great lakes, and the necessity of drawing the water-supply in such cases from the same body of water into which the sewage is discharged, has required the construction of intake tunnels, running out far enough to be beyond all danger of contaminating the drinking water by the sewage.

The most recent important construction of this kind is the new intake of the water works of the city of Cleveland, Ohio, of which a full account is given in the *Engineering Record*, from which the following points are abstracted.

The location of the new intake is situated about $3\frac{1}{2}$ miles from the shore, and about 5 miles from the pumping station, at a point where the prevailing currents will prevent the possibility of the approach of sewage, and from this point is conducted a 9-foot brick-lined circular tunnel with walls 13 inches thick. The tunnel is nearly parallel to the bottom of the lake, at an average depth of 50 to 60 feet below it, vertical shafts at the extremities providing for the intake of the water at the lake end, and the delivery to the pumping engines at the land end.

The construction of the tunnel is now being conducted from three cribs in the

lake, as well as from the shore end, two temporary cribs and shafts having been made, thus giving six headings for tunneling. The strata through which the tunnel runs consist of hard clay with pockets of quicksand and gravel, and thin horizontal seams of quicksand, and during the work but little trouble has been encountered from water, as the air pressure of about 23 pounds to the square inch has been ample to keep back water that might otherwise have entered through the seams of sand.

The details of the air lock, and the constructive features of the cribs and shaft sinking works, form the most interesting position of the work, and these are fully illustrated and described in the article referred to. A curious point in this connection is the fact that the mules are apparently much more seriously affected by the compressed air than are the men, a number of the mules having died suddenly, apparently from the effects of the air pressure.

The fourth shaft, which is to be for the permanent intake and lake connection of the tunnel, will be surrounded by and built through a permanent steel crib, which is

partly completed, but not yet sunk in position. It consists of a cylindrical steel structure 100 feet in diameter and 70 1-2 feet high, with a concentric inside cylinder 50 feet in diameter, both made of steel plates 3-8 of an inch thick, thoroughly riveted and connected by 24 radial vertical plate diaphragms, which divide the annular space into 24 water-tight compartments. The inner well supports a square steel dwelling and lighthouse structure 31 feet in height, which affords storage and a residence for the light-house keeper. The inside well will communicate with the open lake by means of 12 radial inlet tunnels through the annular space, with orifices in both cylindrical surfaces to admit water at levels of 14 and 26 feet below the surface.

The completion of this work, which is now being actively pushed, will give the city of Cleveland a supply of water from Lake Erie from a point so remote from any source of contamination as to be very satisfactory so far as health is concerned, while the size of the tunnel renders the amount of supply practically limited only by the pumping capacity.

THE BRITISH PRESS

The Cost of Electrical Energy.

ONE of the most valuable papers for the year is undoubtedly the masterly essay of Mr. Robert Hammond, before the Institution of Electrical Engineers, upon the cost of generation and distribution of electrical energy, and the widespread attention which the paper has attracted shows very clearly the appreciation of the subject by the engineering and commercial fraternity.

The production and sale of electricity is capable of investigation to a much greater extent than is almost any other industry, since the electric lighting act of 1882 required the filing of detailed yearly statements containing much more information than could otherwise be obtained. This requirement has worked to reduce operating costs and to secure to the consumer a fair proportion of the saving thus effected.

Mr. Hammond has taken these statements from 1890 down to 1896 and 1897 and summarised them in full tabular form, and has then so discussed them as to analyse the various factors of cost and enable definite conclusions to be drawn—at least, so far as the United Kingdom is concerned. In all the tables the figures are given in board of trade units,—*i. e.*, kilowatt-hours,—the cost per unit being given in pence, distributed into costs for coal, oil, waste and stores, wages, repairs, and maintenance, these forming the works-cost, and to these being added rent, rates and taxes, and management expenses, to obtain the total cost. With these is also given the approximate price of coal, thus enabling the influence of fuel cost to be indicated in making comparisons of other factors.

As might be expected, these reports show a great diversity of results, and it is the ascertainment of the causes of these differences that is the main object of Mr. Hammond's analysis. Taking the returns for 1894, 1895, and 1896 as expressing most nearly the existing conditions, and arranging them in order of merit, the total cost per unit ranges from 1.13d. to 6.04d., if we

omit special items such as Crystal Palace, 8.73d., and Salford, 12.57d., which are so far above the others as to be out of the question for purposes of comparison. A review of nine of the leading works shows that a total cost of less than 2d. per unit has been successfully maintained during 1896-1897.

In examining the conditions which make these low costs possible a number of points are to be noted.

In the first place, the data under review show conclusively that output is the greatest factor in the reduction of costs per unit. This is clearly shown by graphical diagrams giving the relation between the number of units sold and the cost per unit, the cost falling rapidly as the output increases from year to year.

The next item bearing upon reduction in cost is the load-factor, or the ratio of the actual units generated to the product of the maximum of the year and the total hours of the year. The advantages arising from a high load-factor are so universally acknowledged that Mr. Hammond produces his data only to sustain the truth of the assumption.

A third element in low costs is the reliability of plant, a perfectly reliable generating and distributing plant having an important bearing on costs. Apart from the obvious necessity of procuring a high-class equipment in the first place, the importance of thorough testing upon installation is insisted upon; no plant should be accepted until it has met a rigid test in every detail.

Closely allied to this is what Mr. Hammond calls the "engineer factor." In every one of the works in which low costs prevail the engineer in charge is distinguished for ability, assiduity, earnestness, and rigid weekly analysis of his works costs. The engineer factor certainly operates in a most important degree toward low costs.

The efficiency of the generating plant

and that of the distributing plant naturally are important factors in the cost question, while the so-called all-round efficiency is an item in which the two are combined. These are discussed by means of curves and tables, and a general summary shows the relative importance of the various items.

While many of the factors are rather administrative than of an engineering nature, the two are so closely interwoven that it is instructive to see them handled by an engineer in so forceful a manner, and, although many of the points made by Mr. Hammond are of a local character, in the main his conclusions apply in all countries where electricity is used to any great extent.

In conclusion, Mr. Hammond ventures into the dangerous region of prophecy, based, however, upon past experience of a definite nature, and predicts that when, in the city of Leeds, the output reaches 5,000,000 units, the total costs will be reduced to 0.75d. per unit.

Crank Arrangement in Quadruple Engines.

THERE has been some difference of opinion as to the most advantageous arrangement of cranks in quadruple-expansion engines where the four cylinders have independent crank connection, and the results of a number of experiments form the matter of a paper by Mr. A. L. Mellanby, read before the North East Coast Institution of Engineers and Shipbuilders, at Newcastle-upon-Tyne.

The main object of the trials was to find out which was the better of the following arrangements,—the cranks H. P., 1st I. P., 2nd I. P., and L. P., in the order given, or the cranks H. P. and 1st I. P. opposite each other and at right angles to the 2nd I. P. and L. P.

The tests appear to have been made with much care, and the definite character of the results speaks well for the accuracy of the work. The engines were of the vertical marine type, with four cylinders and four cranks, the sizes of the cylinders being as follows: high pressure, 7 inches; 1st intermediate pressure, $10\frac{1}{2}$ inches; 2nd intermediate pressure, $15\frac{1}{2}$ inches;

low pressure, 23 inches; common stroke, 18 inches. The crank shaft was arranged with couplings which permitted the order of the cranks to be readily changed while all other conditions remained unchanged; hence any variation in efficiency could be attributed to the true cause.

By the use of the Froude hydraulic dynamometer the entire power of the engine could be absorbed and measured, while measuring-tanks enabled the amount of feed-water to be measured; the detailed results of the tests therefore contain information of general value as to the performance of this type of engine, apart from the facts as to the especial point under investigation. Tests at various pressures were made, with the principal object of checking the general results, for, as Mr. Mellanby remarks, the only really important ones are those made at 210 pounds pressure, as it is not advisable to work a quadruple-expansion engine in actual practice at a pressure much below this.

The results of the two series of trials are given in the paper, both in tabulated form and as plotted curves, showing very clearly a marked advantage in the arrangement called "cranks opposite,"—*i. e.*, with the H. P. and 1st I. P. opposite each other and at right angles to the 2nd I. P. and L. P.

Taking the tests at 210 pounds' pressure, the water-consumption per horse power (brake) per hour for the cranks opposite is given as 14.03 pounds, or 12.53 pounds per indicated horse power; while for cranks at right angles the corresponding figures are 14.39 and 12.77 pounds respectively. These are good figures for an engine indicating only about 150 h. p. under any circumstances, especially as this is an actual measured water rate, and not one computed from the indicator diagrams. The brake horse power averaged about 90 per cent. of the indicator power, and the general consistency of the results adds value to the figures as reference data.

Mr. Mellanby makes some excellent remarks upon the general subject of engine tests, and calls attention to the necessity of examining the results from isolated trials very carefully, as, from the nature of the case, errors are liable to creep in, which,

with only one determination, may be lost sight of. This, without doubt, has much to do with the conflicting results of engine trials, and it is to be regretted that so many sweeping assertions have been made from the results of one or two trials. When a number of tests are made, each can be used to check the others, or, when the results are plotted in the form of a curve, any wide deviation from the evident general trend can be re-examined and errors can be eliminated.

In connection with the effect upon efficiency due to arrangement of cranks, the question of steadiness of turning moment must also be considered. There is a notion prevalent that the turning moment for a four-crank engine must be very uneven, especially for the arrangement called "cranks opposite," which some engineers consider almost as bad as that for a two-crank engine. The actual curve shows that this is not so, the turning moment being very steady throughout a revolution. There is practically no difference between the minimum and the maximum values for the two cases, although the "cranks opposite" seems, on the whole, to have the steadier turning moment.

Balancing Steam Engines.

IN a careful review of a paper on balancing steam engines, read before the Manchester Association of Engineers by Mr. James Whitther, the *Engineer* brings out some points of value which are not always sufficiently considered.

The fundamental principle which must not be overlooked in the practical operation of balancing is that a rotating mass cannot be made to balance a reciprocating mass, but that only rotating masses can be made to balance each other. In the cases of high-speed engines, with several cranks, the problem of balancing becomes one in which the correct theoretical principles must be fully understood and correctly applied, if a fair measure of success is to be attained.

Let us leave for a moment all reference to the reciprocating parts of a steam engine, and confine ourselves to the rotating elements only. Every rotating mass or

group of masses tend to revolve around its common centre of gravity, and, if it is permitted to do this, peace will prevail, and there will be no vibration.

To use Rankine's words: "The condition which it is desirable to fulfil in all rapidly rotating pieces of machines is that the axis of rotation shall be a permanent axis. The question whether the axis of a rotating piece is a permanent axis or not is tested experimentally by making the piece spin rapidly, with its shaft resting on bearings which are suspended by chains or cords so as to be at liberty to swing. If the axis is not a permanent axis, it oscillates; if it is, it remains steady; when the axis of rotation traverses the centre of gravity of the piece, there is said to be a standing balance; when it is also a permanent axis, there is a running balance."

It is this difference between a running and a standing balance which makes it impossible for cranks even a few feet apart to balance each other, even though identical in weight and dimensions and placed at an angle of 180° . Each crank must be balanced by its own counterweights, placed as nearly as possible in the same plane of rotation, so that the centre of gravity of the crank and of the balance weights can be made to coincide with the centre of the shaft, and also with the middle point in space between the two crank cheeks.

Taking up now reciprocating masses, it must be considered that only reciprocating masses can balance each other. The reciprocating masses must move in opposite directions; if not in the same plane, then in not fewer than three planes. As an example of the counter-balancing of reciprocating masses in three planes may be cited a three-cylinder vertical compound engine, with cylinders all of the same size, the central one being high-pressure, the other two low-pressure, and the weights of the moving parts of the two low-pressure portions just equalling those of the high-pressure part. The cranks being counter-weighted separately, and placed 180° apart, such an engine should run without vibration, reciprocation and rotation taking place in three planes, which fall between the crank shaft bearings.

In the case of triple-expansion engines, with three cranks at 120° , the parts cannot be made to balance each other, and so "bob" weights must be added. It is suggested, however, that the combination above described, with the addition of a tandem cylinder on top of the middle section, would enable a triple-expansion engine to be constructed capable of perfect balance by the proper distribution of the weights of its own moving parts, without the need of any "bob" weights.

The whole subject is one which, while requiring care and study, demands rather the exercise of judgment and common sense than the application of an elaborate mathematical analysis.

The Electric Driving of Machine Tools.

IN the development of electricity as a means of power-transmission one of the most important applications is only beginning to be appreciated,—namely, the distribution of power to the various tools in the machine shop.

A recent article in the *Electrician* calls attention to the progress which this branch of applied electricity is making in various countries, and discusses some of the conditions of its development.

One of the earliest machine-shop appliances in this class was the electric crane, and there is little doubt to-day that electricity is, *par excellence*, the motive power for just such service as is demanded for hoisting and handling materials. It is, indeed, interesting and curious to note that, in England at least, the class of works in which electric driving has received its earliest adoption has been one demanding large amounts of power and involving heavy strains upon the driving machinery. Nowhere has electric driving been so extensively and successfully practised as in the shipbuilding yards and engine works of the north-east coast. Yet experience has amply demonstrated the suitability of electric driving for every-day work of this most severe description; indeed, the test of electric trolley lines had already shown the applicability of electricity to intermittent and irregular work, and few machine shops

offer the trying conditions that are daily met on every electric tramway.

At the same time it is the flexibility of its character which renders electric driving of so general adaptability, for, in workshops where the work is lighter and of a more delicate character, the electric motor has shown its fitness, an excellent example of this being a bicycle factory.

As to the system to be preferred for shop driving, it is yet too soon to predict. Direct currents have been employed with success, while on the continent and in America the two-phase and three-phase systems have been extensively used. Separate motors are to be preferred in most instances, especially when the utmost steadiness is desired, dispensing with intermediate belting or other forms of gearing; but in many shops the group system of isolated countershafts, each with its own motor, and each furnishing power to its own group of near-by tools, has been found advantageous.

When we consider the losses by the use of shafting, belting, and gearing in the ordinary methods of power transmission in machine shops, the greatest economy in the use of electricity is found to result from the elimination of the frictional losses, which, under existing methods, often amount to more than one-half of the total power generated; and there seems to be every reason to expect that ultimately nearly all the distribution of power for manufacturing purposes will be made by the electric current.

Feed Water.

THERE are a number of so-called minor details in steam engineering which, in the total, amount to an important item, so far as the economic performance of a plant is concerned. Among these must be included the purity of the feed water from which the boilers make their steam. An excellent editorial in the *Engineer* discusses this subject from a common-sense point of view, and shows how much may be gained by giving proper attention to the character and suitability of the feed water used under any given circumstances.

Much of the neglect with which this matter has been treated is due to the fact that almost any water, however bad, can be used for a time to make steam; and the lower the pressure, the longer the period during which a boiler may be worked without being ruined with even very bad water.

With modern high pressures, however, every defect in feed water is aggravated as the pressure rises. The salts of lime and magnesia are thrown down with increasing rapidity, and in larger quantity as the pressure and temperature increase; so that the deposit becomes denser and more adherent at the very time when the metal is rendered less able to withstand it. Indeed, engineers generally appear to be waking up to the fact that something will have to be done in the way of improving feed water, if the increase in steam pressures is to be continued.

It is well known that absolutely pure water is not good for boilers. Indeed, boilers which have been badly scaled have had the scale quickly dissolved and removed by the use of a very pure feed water, and, if there is no scale to dissolve, the boiler itself will soon show evidence of pitting and corrosion. On the other hand, too much lime, either in the form of carbonate or sulphate, will soon produce "furring" and thick scale, with the inevitable accompaniments of diminished efficiency and possible burned tubes or collapsed furnaces. "Long practice has proved that the best possible results are obtained where all the interior of a boiler becomes covered with a very thin continuous scale of lime. No doubt there is a small loss incurred by the presence of the non-conductor. On the other hand, the durability of the boiler is enormously increased. Indeed, when such a scale can be maintained, the boiler is subject to no wear whatever from the inside, and would last for an indefinite time, were it not for the effect of the hot gases on the tubes and plates outside. This scale can always be attained afloat by filling the boiler with sea-water, and disregarding the rise in density which invariably, from some hitherto-unexplained cause, takes place

when the same water is used over and over again. When in port, the whole of the water in the boiler may be blown out and the boiler filled up again from the sea; but all loss when on a voyage should be made up with fresh water from an evaporator. On land there is no difficulty in getting the scale; the trouble lies in preventing it from becoming too thick."

Without attempting to suggest any especial panacea for bad feed-water, it is at least worth while to call attention to the increased necessity of providing better water, in view of the higher pressures now in general use. The correspondingly-increased temperatures cause a precipitation of sulphate of lime, which forms hard scale, and the liability to burning is altogether too great to be overlooked.

"The difference in the cost of boiler maintenance depends to an extent that is not generally realised on the quality of the water; and it is not too much to say that in every well-appointed works or factory appliances for softening, purifying, and heating feed water are as essential as the boilers themselves. Regarded as an investment, there is no other from which the steam-user will get a better return for his capital."

The Iron Resources of India.

THE large importations of iron ore from Spain form an important item in the supply of material for one of the chief steel-making processes of the United Kingdom, and the visit of the members of the Iron and Steel Institute to Bilbao in 1896 gave the members an excellent opportunity of judging the extent to which Spain has been the gainer from this source.

An editorial in a recent issue of *Engineering* calls attention, however, to the possibility of keeping this business to a large extent in the British empire, since there are ore deposits in India which might partially, if not altogether, replace those from which the Spanish supplies are drawn. The matter is all the more worthy of consideration, since it is understood that the Spaniards are casting about to see how they can become steel makers in place of simple ore producers—cutting at

the British steel trade, which brought the Spanish ore industry into being, and making it all the more desirable that a substitute imperial product should be used.

The *Times* has pointed out that iron ore abounds at Chanda, in the central provinces; the Iron Mountain containing crystalline hematite of extreme purity, while at other places are deposits of a most tempting nature, the ores being described as almost entirely free from phosphorus.

The cheapness of labour and the comparative proximity to the sea should also render these ores successful in competition with the American product, the deposits being less than four hundred miles from Bombay.

Another possible source of ore is found in the Salem district, in the province of Madras, upon which an exhaustive report has been made by Mr. Jeremiah Head. The argest and most accessible deposit is that known as the Kanjamalai. "It is six miles from Salem, and close to the railway which connects the city with Madras on the east coast, the distance being 200 miles, whilst Calicut, on the west coast, is 180 miles distant. Kanjamalai is a hill, having three principal beds of magnetite, each on the average 50 feet thick, $4\frac{1}{2}$ miles long, and $1\frac{1}{2}$ miles broad. According to a section given, the deposits extend from side to side of the hill, dipping boldly in the centre and cropping out fully at the surface. The possible yield of the three beds is estimated at 900,000,000 tons, supposing there is no interference, being equal to the total exports from Bilbao for 225 years."

The matter of the possibility of profitable export of these and other Indian ores is one to question, but it may be worth while to investigate the practicability of smelting the ores in India. Mr. Head is of opinion that this depends largely upon the question of the supply of charcoal fuel, but is also complicated with local financial and transportation matters. He is unable at present to see how iron can be manufactured in India from native ores cheaply enough to make it a competitor of imported pig, but the introduction of extensive modern methods may overcome these difficulties, and enable India's riches

in iron to be so developed as to divert the large sums now paid to Spain to a point in the British empire at present undeveloped in this respect.

Railway Progress.

THE inaugural address of Mr. Samuel Waite Johnson, the new president of the Institution of Mechanical Engineers, dealt with a subject upon which he was especially fitted to speak, and one which, as he remarked, had not formed the theme of any of his predecessors.

The history of the growth of railways is equally the history of the growth of mechanical engineering; for, even in its latest development,—the electrical production of power and light,—we have not only railway stations, passenger coaches, and goods yards profusely lighted by electricity, but also both overhead and underground railways worked successfully by the same agency, and paying dividends to shareholders.

The close relation between the development of railway enterprise and the general prosperity of the country renders the growth of British railways an excellent index of the prosperity which has prevailed during the Victorian era, and it is interesting to observe that the plotted returns of the board of trade form an excellent record of the fluctuations in general trade conditions.

Without attempting to account either for the fact or for the time interval, Mr. Johnson called attention to the recurrence of periods of prosperity at intervals of eight or nine years. The first prosperous period shown by the passenger returns began about 1862, and the succeeding ones in 1870, 1879, and 1888. On the whole, since 1862 the increase has been wonderfully regular, the periods being generally most clearly marked when the figures for the United Kingdom are taken, and least regular when only a single railway is considered. Similar periods are shown for the goods and mineral traffic, but the periods of depression are much more marked than for passenger traffic, and reach their greatest intensity a year or two earlier. Marked irregularities are

also introduced by strikes, and by other trade disputes.

These and other relations which have developed during the sixty years of railway progress in Great Britain were clearly exhibited by Mr. Johnson, with the aid of diagrams and tables.

In 1855 the longest run was 24 miles and the speed 42.3 miles per hour. In 1897 the longest run was 124 miles and the speed 52 miles per hour,—a very considerable increase in view of the increase in the weight of trains.

The advances in locomotive construction and design have, of course, been most marked, and the present practice of the Midland road is especially interesting. Piston valves have not come into general use for locomotive engines, although in a well-known type of American compound engine they are employed; but Mr. Johnson has adopted the piston valve for his single-driver express locomotives. Compound engines have not yet found acceptance on his road, largely because of the excellent economical performance of the simple engines.

A marked gain in fuel economy has been attained in recent years, and during the eight years terminating in 1880 the consumption showed a decrease of 9.68 pounds per train-mile, or 17.22 per cent. of the amount of fuel formerly burned, this large reduction being effected by revising engine and boiler details and by building locomotives of greater power and therefore better capable of dealing with trains.

The improvement in permanent way has necessarily kept pace with the development in rolling stock, and the substitution of steel for iron, both in rails and in bridges, is an advance without which the present rate of traffic could not safely be maintained. The old wrought-iron fish-belly rail, weighing only 35 pounds per yard and only 15 feet long, has been replaced by the modern steel rail, which weighs 100 pounds per yard and is 36 feet in length.

Mr. Johnson expresses freely his preference for a gauge of 5 feet 3 inches, mainly on account of the crowding of the machin-

ery between the frames which is necessary with narrower gauges; but this is evidently the consequence of the use of inside cylinders. For outside connected locomotives the standard gauge of 4 feet 8½ inches is found wide enough.

Many interesting and valuable points in the address are necessarily omitted in this brief glance, as well as the numerous illustrations, which added much to the force of the historical portions.

In closing, Mr. Johnson emphasised the value of such a retrospect in giving confidence for the future, because the conditions affecting both railway and marine engineering, which have so greatly promoted progress in the past, are still dominant, and these two branches of locomotion have brought all parts of the world within comparatively easy reach of one another, thus enabling the "old country" to profit by the growth of the more distant portions of the empire, as well as by the prosperity of neighbouring nations.

—

The Staines Reservoirs Scheme.

THE extensive plans for the increase of the water-supply of London, the execution of which is already in progress, will doubtless furnish much valuable experience in the department of water-works engineering. We refer at present only to the general outline described in recent issues of the *Journal of Gas-Lighting and Water-Supply*.

The scheme includes the construction of a number of storage reservoirs in the neighbourhood of Staines, taking the supply from the Thames, the Wraybury river, and the Colne brook, the water to be delivered to the three London water companies for distribution. The maximum quantity of water to be taken from the Thames is limited to 100,000,000 gallons, and no more than 35,000,000 gallons is to be delivered to the three companies on any one day, except in case of emergency, in which case the amount may be increased to 45,000,000.

The water is to be taken from the Thames on the Middlesex bank, a short distance above Bell Weir, by a powerful installation of pumping machinery, and

delivered to the reservoirs through two riveted steel mains, each 6 feet 3 inches in diameter, joining into a steel pipe 8 feet 8 inches in diameter, from which branch pipes will be run to the reservoirs.

The impermeable character of the London clay, upon which the reservoirs will be founded, makes the construction a matter of contract work rather than of great engineering skill, but the great size makes the undertaking a notable one. The embankments will vary from 21 to 35 feet in height, and will be formed of material excavated from the interior of the reservoirs. The slopes of the embankment are three to one inside, and two to one outside, the reservoirs. In the centre of each bank a puddle wall will be constructed 6 feet thick at the top, 7 feet at the ground level, and tapering down to 5 feet where it joins the London clay, into which it will be securely toothed, this construction being relied upon to make the reservoirs perfectly tight. The insides of the slopes are to be lined with concrete, so as to resist the wave action expected to take place on a body of water so large as this will be. Reservoirs No. 1 and No. 1A will be about $1\frac{1}{4}$ miles long by $\frac{5}{8}$ of a mile wide at the northern end, and nearly a mile wide at the southern end.

The content of the reservoirs originally authorized was 2,500,000,000 gallons, which it is proposed to increase to 3,300,000,000 gallons.

This increase has been undertaken by the Joint Committee, because, having already purchased a portion of the land, the extension, which will be an additional safeguard to the Thames in times of drought and will be in the interest of the consumers, can be made at moderate cost. The aqueduct and reservoirs will be guarded on all sides by an unclimbable wrought-iron fencing; and the embankments will be sown with grass.

The conduit will be carried under the London and Southwestern Railway and follow the line of the Staines and Kingston Road to Sunbury Cross from which it will be diverted to a reservoir of about 30,000,000 gals. capacity to be constructed to the east of Kempton Park. The New River Company will take its water from the aqueduct between the East London Water Works and the Thames Valley Line, while the Middlesex and Grand Junction Companies will receive their proportion of water from the Kempton Park reservoir; proper measuring apparatus being provided at the Thames inlet and at the companies outlets.

THE CONTINENTAL PRESS

Blast-Furnace Power Gas.

THE interest in the practical application of the waste gases from blast furnaces for the generation of power in gas engines has already been discussed here more than once, but the subject appears to attract continual attention in the technical press on both sides of the Atlantic.

Following the discussion on Herr Lürmann's paper, read before the Verein deutscher Eisenhüttenleute at their recent convention, and noticed in these columns last month, we have an editorial discussion in *Stahl und Eisen*, with special reference to the tests made by Professor Hubert upon a blast-furnace power gas plant at Cockerill's works, at Seraing, Belgium.

These tests are of especial interest in this connection, because they include a careful investigation of the character and calorific power of the gases and an examination of the value of the methods of using them prior to the application of the gas engine; and it is not too much to say that the results of Professor Hubert's work fully answer the objections made by Herr Lürmann as to the feasibility of the introduction of the method.

A number of tests of the gases, both by analysis and calorimeter, showed an average of 997 calories per cubic meter, and about 40 per cent. was used in the hot blast stoves and the remaining 60 per cent. burned under steam boilers; but, in order to be on the safe side, Professor Hubert takes only fifty per cent. of the gas output as available for power generation, leaving the other half to be used for heating purposes.

The engine in which the gas was tested was of the style known as the "Simplex" gas engine, with slight modifications adapting it to the character of the gas, the principal changes being the use of a higher degree of compression than is required for illuminating gas, and the addition of an accumulator in connection with the electrical ignition. The addition of a simple

washing apparatus was found sufficient to remove the dust and mechanical impurities from the gas to an extent which made it clean enough to prevent injury to the cylinder of the engine, as is shown by the fact that the gas engine at Seraing ran continuously for a year with furnace gas without any serious injury.

Without going into the details of the tests, it may be of interest to give in full the conclusions at which Professor Hubert arrived, bearing in mind the fact that these are deductions from theoretical investigation and practical experience.

A. In the production of one ton of pig iron there are also produced about 5750 kilograms of gas, or about 4,300 cubic meters, at 150 C. A 100-ton blast furnace will produce therefore about 18,000 cubic meters of gas per hour.

B. Under the assumption that fifty per cent. of this gas is used in the hot-blast stoves, there remain 9,000 cubic meters available for power, which, with an efficiency of twenty per cent. for the gas engine, at 1,000 calories for the thermal value of the gas, corresponds to 3,000 h. p. as the value of the gas from a 100-ton furnace, or from three to ten times the power hitherto produced by burning the gas under steam boilers.

C. From the tests upon the engine at Seraing, which has been in successful operation for more than a year, the consumption of gas is between four and five cubic meters of gas per h. p. per hour.

Taking the maximum consumption of five cubic meters, we have a practical result of 1,800 h. p., of which only 400 is required for the purposes of the furnace, leaving 1,400 available for other purposes.

D. With the progress which has been made in the design and construction of large gas engines, there is every prospect that we may soon have blowing engines operated by gas motive power cylinders, thus enabling the entire power to be obtained by the utilisation of the furnace gases.

E. The use of the gases as a direct source of power will greatly reduce the first cost of the plant by dispensing with the expense involved in the steam boiler plant, the gas engines themselves replacing the steam engines.

F. The cost of the water for the cooling and washing of the gas and for the cylinder jackets of the gas engines is not greater than that for condensing purposes in the case of condensing steam engines, so that no extra charge is to be made for the gas engines on that account.

G. When, as is now frequently the case, the blast furnaces form part of a general iron and steel works, in which large quantities of power are required for rolling mills, forges, machine shops, etc., the power produced by the gases in excess of the furnace requirements is directly available for the other mechanical operations, thus enabling such plants to compete, so far as power cost is concerned, with the great hydraulic power installations which depend upon natural sources of energy.

The matter seems to be passing well out of the hands of the investigators into those of the constructing engineers. It is now the turn of the engine builders to produce large gas engines, especially adapted for use with lean gas, and suited for continuous heavy duty, and the part of energetic ironmasters to take active steps to introduce the new system. Already, it is reported, a blowing engine to be operated by gas power is being designed for the Cockerill company, and others should not be slow to follow.

Automobile Vehicles.

ALTHOUGH the subject of motor carriages and other automobiles has received earnest and practical attention both in England and in the United States, it is on the continent that the most activity has been shown, in the construction of both light and heavy vehicles.

A very full and lavishly-illustrated review of the present state of automobile construction has been contributed to the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* by Professor Czischek, himself well known as a pioneer in

this field, and a designer of an effective form of steam tricycle.

In discussing the subject, Professor Czischek first considers the resistance to be overcome on roads of various kinds for vehicles of different weights, using as data the results of the experiments of Michelin in Paris, to which he adds the not unimportant factor of wind resistance, and shows how the actual horse power required for any given conditions of operation may be computed. The formulas for this purpose are checked by the results of the "poids-lourdes" competition in France, and also compared with the *Times-Herald* trials at Chicago, the results being tabulated in a form which renders them available for reference for future design.

In considering the sources of motive power available for automobile purposes, steam is first discussed; then the various kinds of internal combustion motors, using petroleum, benzine, acetylene, and similar materials, these having been more extensively employed on the continent, perhaps, than any other forms. The use of electric accumulator batteries is also referred to as undoubtedly the most elegant solution of the motive power problem, and some examples of storage-battery vehicles are given; but so far electric power has been given more successful application in England and America than elsewhere.

As Professor Czischek rightly observes, the most difficult point in automobile design lies in the transmission of the motive power to the point of application, the mechanism for this purpose necessarily differing materially for different kinds of motors. The benzine motor, for example, runs at a constant speed of about 700 revolutions per minute, and requires a reduction to a speed varying between 25 and 100 revolutions on the driving wheels. Electric motors are more readily controlled, but also require much reduction. Probably steam is more easily handled, as regards actual speed and changes in velocity, than any other motive power, but the objections to it in other directions are obvious.

Many of the constructive details of motor vehicles have been adapted from bicycle

construction, the wheels, ball-bearings, pneumatic tires, etc., having been used almost without change, except as regards dimensions. Other portions of most of the vehicles have been supplied by the carriage-maker, and the result is sometimes almost ridiculously incongruous; the heavy leather work, dashboards, and other details evolved after generations of horse propulsion, still being retained, though the necessity of their existence has vanished. In this respect the small vehicle of de Dion and Bouton and the larger one of Bollée are to be highly commended, as most free from the trammels of precedent in carriage design, and as exhibiting more fully than others the idea of adaptation of means to end, regardless of practice in the construction of horse vehicles.

Motor vehicles have undoubtedly come to stay, or, rather, to go, but there is still much room for improvement. The improvement in roads will certainly have much to do with the improvement in the vehicles, and in this respect road construction and vehicle design must react upon each other.

The Jungfrau Railway.

SINCE 1889 several plans have been made for the construction of a railway by means of which tourists could reach the summit of the famous Swiss mountain peak known as the Jungfrau, hitherto reached only by experienced climbers assisted by capable guides; but the earlier schemes, involving cable traction, expensive tunnelling, and excessive grades, were never executed, and it remained for the latest plan of Herr Guyer Zeller, president of the northeastern railway system of Switzerland, to be carried to success.

Various accounts of this important and unique work, now approaching completion, have been given to the public, but one of the most elaborate is that recently presented before the German Railway Society by Dr. Wrubel, of Zurich, and published in *Glaser's Annalen*.

Although the altitude of the Jungfrau above sea-level (13,670 feet) is a little less than that of Pike's Peak, the origin of the Swiss road is lower than that of the Ameri-

can one; so that the Jungfrau road will have the greater vertical rise, the maximum grade being about the same in both instances,—*i. e.*, about 25 per cent. The great feature of the Jungfrau railway, however, is operation by electricity, instead of by steam locomotives, the current being derived from water power obtained from the two branches of the Lütschine, near Lauterbrunnen. Only a small volume of water is available, careful gaugings showing a flow of 6 cubic meters per second in summer and but one-third as much in winter. The fall, however, in two stages of 38 and 150 meters, gives to this small volume of water a maximum power of more than 11,000 h. p., and, as there is ample water during the tourist season, and the road is not to be operated in winter when the flow is diminished, there is no question about the sufficiency of the power-supply.

The electric system will consist of a three-phase current at 7,000 volts' pressure, which will be transformed to 500 volts for use in the electric locomotives, which, with the generators, are being built by Brown, Boveri & Co., of Baden. A portion of the electric system is already installed, the current being used for the purposes of railway construction, tunnelling, etc., and the feeding wires following the work as it advances.

An interesting feature of the scheme is that the grant of the concession to Herr Guyer Zeller and his associates included the requirement that the system should involve no injury to the health of passengers by the too rapid ascent into a rarefied atmosphere. A number of experiments were instituted to ascertain the physiological effect of a change of atmospheric pressure, at different rates of speed, persons of various ages and conditions being placed in chambers, from which a portion of the air was removed more or less rapidly; and, in view of the results of these experiments, and of data obtained from balloon ascensions, the authorities concluded to omit the health clause. The trouble of these tests might have been avoided, had the experience gained upon the Pike's Peak railway been considered, since the ascent there to an altitude of

14,147 feet in a few hours does no harm to the passengers. It is well known, moreover, that mere altitude is not the only element in producing ill effects, as the dread soroche of the Peruvian Andes is felt on the Lima and Oroya railway at points much below the town of Oroya, where the altitude is but 12,000 feet, and the ascent more gradual.

Although active work is in progress upon the Jungfrau road, the difficulties of construction will render its progress slow. It is expected that the Eiger glacier will be reached by 1900, but that the completion of the entire road will occupy five or six years.

The terminal of the road is not at the summit of the Jungfrau, that sharp peak being accessible only by a vertical lift; hence the last portion of the journey is to be performed in an electric elevator, the lift being 73 meters (240 feet), and delivering the passengers at the very summit.

The road is being constructed with steel cross-ties, the central rack rail being on the Strub system, and the electric locomotives are being designed with double motive power throughout and a quadruple system of brakes, both electrical and mechanical, there being one mechanical brake by which both sides of the central rail can be grasped, independently of any of the driving mechanism, thus affording a measure of security which renders failure highly improbable.

Water Transport and Grain Imports.

FOR several years there has been much agitation in various parts of Germany and Austro-Hungary in the matter of better and greater facilities for internal transport of merchandise, especially by means of canals and canalised rivers; and a number of schemes have been discussed, some of the more important of which have been noticed in these pages.

One of the reasons why there has been little more than talk thus far may be found in the conflict of interests concerned in the ultimate effects of such improvements in internal waterways.

In the Westphalia district the mining interests are seeking relief from the con-

stant congestion in the facilities for transportation of coal, while the agricultural sections of western Europe look askance on anything which will benefit the competition of the grain from Hungary and southern Russia.

All these conflicting interests, however, may become united in contemplation of the common competitor which is found in the United States, and it may be that the necessity of meeting the importations of American grain by some reduction in continental transport expense is the factor which is to unite the opposing elements, and further the cause of internal waterways in central Europe.

It is doubtless with this object in view that Herr von Gunesch presented before the Austrian Society of Engineers a very full paper on the development of internal waterways in America, and their influence on its exports to Europe, and in the paper and discussion, published in the *Zeitschrift des Oesterr. Ingenieur Architekten Vereines*, some interesting features are brought out, especially in regard to the relations between engineering and commerce.

The paper contains a brief historical review of the development of the Erie canal, with sections of the channel, and plans of the capacity of locks at various dates, showing the continual increase in capacity, while tables are also given of the tonnage, etc., for the successive decades since 1837.

Coming more directly to the question at issue, Herr von Gunesch proceeds to compare transportation costs, especially for grain, between the United States and central Europe, and shows that, if in the United States the expenses of handling and breaking bulk are eliminated by the completion of the waterway communication between the great lakes and the ports of Europe, either by direct loading of seagoing vessels or seagoing barges, the competition will force Europe to do something to meet it.

Taking the figure deduced from Captain Symonds's report to the American Deep Waterways Commission, Herr von Gunesch shows that it will be possible to transport grain from Chicago to Laube,

the grain center of Moravia, by way of Hamburg, for practically the freight charge now made from Budapest to Laube, although the distance in the former case is about 6,000 miles and in the latter only 435 miles.

Herr von Gunesch then proceeds to show how, by the construction of a system connecting the Danube, Moldau, Elbe, and Vistula by canals, the present cost of transport from the grain fields of central Europe could be reduced to a figure which would meet the American competition. Hungarian grain could then be delivered at Hamburg as cheaply as American grain, while from Moravia the cost of transport would become less than half the present rate, and but little more than half the rate from Chicago to Hamburg.

The importance to central Europe of the construction of waterways for internal transport is now undoubted, and the paper to which we have referred shows that, while internal interests may be somewhat disturbed, the pressure of external competition will be too great to be resisted, and that engineers will doubtless soon be set to work constructing these new outlets for commerce.

A Powerful Crane.

THE port of Hamburg is already provided with several heavy cranes, but the most recent addition to the handling devices there installed is a powerful derrick-crane of 100 tons' (metric) capacity, constructed by the Duisberg Machine Works, for the ship-building yard of Messrs. Blohm & Voss, and illustrated and described in the *Zeitschrift des Vereines deutscher Ingenieure*.

Apart from its large capacity, the crane possesses several points of ingenious novelty, combining to a certain extent derrick and shears. The general construction of the crane proper is that of a braced jib, made up of lattice girders, and rotating upon a swivel base. The upper pivot is supported by three inclined pillars resembling shear legs, except that they are fixed, the vertical axis of the radial jib being as close to the edge of the quay wall as the diameter of the bottom bearing

plates will permit. The upper part of the jib is divided, with a pivot joint in the lower member and a pair of screw connections in the upper girder, and by the action of the screws the radius of the jib may be varied so that the overhang can be made anything between 32.5 and 17 meters.

There are two separate systems of hoisting tackle, one operating with four parts of wire rope, and taking loads up to 30 tons, the other with eight parts of rope, for loads up to 100 tons. The general arrangement of the crane renders it especially adapted for the purpose of installing heavy machinery, boilers, engines, masts, etc., on vessels which may be floated up the side of the dock, and, as a fine piece of mechanical engineering, it is well worthy of study.

The New Terminal of the Orleans Railway.

IN a previous issue we called attention to the important plans made for a new terminal station in the heart of Paris, on the site of the ruined Cour des Comptes, and in the *Génie Civil* we now have further account of the station, as well as of the subway by which it is to be approached, and illustrations of the preliminary work of demolition and preparation.

The final design accepted by the company for the building is that of M. Laloux, and from the illustrations given there seems to be but little doubt that it will be an ornament to the city.

In the construction of the subway, which is to connect the new station with the present Orleans station at the Pont d'Austerlitz, a number of difficulties are to be encountered in the form of existing obstructions, for which other provision must be made.

At the present time both banks of the Seine have beneath them the main collecting sewers that receive the discharges of the smaller sewers which formerly delivered into the river, and, in order to make way for the railway tunnel, the collector on the left bank must be deviated from its present position. It is intended to carry the new main sewer under the boulevards Saint Germain and Saint.

Michel, and this will remove it to some distance from the bank of the river. It will also be necessary to reverse the slope of the smaller sewers from the river bank inward, so that they will deliver into the new collector. Corresponding changes will be required in the gas and water pipes, and the cost of making all these changes forms an important item in the total expense.

The magnitude of this work is such that it can be shown in the technical journals only in its successive stages, and the principal points of the article above noted refer to the preparatory work, not only in reviewing the underground obstructions, but also in clearing the surface where the new buildings are to be erected. All along the quai d'Orsay the preparations for the subway construction are in evidence, while in the heart of old Paris, between the rue de Lille, the rue de Bac, and the rue de Bellechasse, the demolition of the ruins of the Cour des Comptes, which had remained almost the sole reminder of the Commune of 1870, is a scene which attracts much attention.

It is believed that the completion of this station will be of especial advantage, in that it will enable residents of the suburbs and of the country for some distance around Paris to make frequent visits to the city, as the terminal is to be so conveniently situated with regard to the principal business locations and other centres of interest that little or no time will be lost in traversing the city. Hence visits even of a single day can be made to advantage.

The work is intended to be entirely completed before the opening of the exposition of 1900, as the new terminal is to assist to a great extent in handling the crowds.

The total cost of the improvement is estimated at 40,000,000 francs, of which nearly one-half is for the construction of the subway and the diversion of the sewers and other obstructions, and nearly one-third for property damages and land purchases. The building of the terminal, it is estimated, will cost more than 9,000,000 francs.

The Grisoumetre.

At the present time much attention is being given in the various mining districts on the continent to the subject of fire-damp and the best methods of preventing explosions in collieries where the production of dangerous gases is a possibility. In many of the districts careful records are kept of the relation of the production of gas to the variations in barometric pressure, in order that the fall in the pressure of the atmosphere may be used as a warning of possible danger; and in nearly every case care has been taken to investigate the liability of the mining explosives to ignite the mine gases. We have also noted at length the experiments of Heise and Thiem upon the conditions under which electric apparatus in mines may be a source of ignition of explosive gases, and, on the whole, this important subject is being very thoroughly investigated.

In France especially the work of studying the explosive nature of various mine gases has been carried on by Dr. Grehant, and, in a recent lecture published in the *Bulletin de la Société d'Encouragement*, he describes and explains very fully the action of his so called "grisoumetre," or apparatus for determining the proportion of combustible gas existing in a sample of mine air submitted for examination.

The principle of the grisoumetre is that of burning the combustible portion of the sample of air, by an incandescent spiral of platinum wire, measuring the reduction in volume, and deducing by the difference the proportion of fire-damp which must have been present. The measurement is accomplished by having the combustion chamber form the upper part of a graduated tube, so that the only observations necessary are readings of the graduations before and after the passage of the electric current; but special precautions have to be taken to insure the constancy of all conditions, such as temperature, pressure, etc., and the auxiliary devices for these purposes form essential parts of the apparatus, as Dr. Grehant clearly showed.

The apparatus should be carefully calibrated by the use of samples of gas whose composition is accurately known, after

which its use is very simple and rapid; as Dr. Grehan suggests, it should be used daily, thus enabling any marked deviation from the normal condition of the mine atmosphere to be noted at once. Dr. Grehan gives examples of four determinations of widely-differing mixtures, indicating the proportion of methane to within one-tenth of one per cent., each examination requiring but fifteen minutes.

In view of the great risks incurred by operating mines in which fire-damp is liable to appear, the trifling cost which the use of such an apparatus involves seems a very low rate of insurance to pay for the protection of property, to say nothing of the lives of the miners; and the general introduction of such a device in all gaseous mines cannot be too strongly recommended.

Marine Engine Shafts.

THERE is scarcely any element in machine design which is of greater importance than the main crank-shaft of a modern ocean steamer, the conditions of its operation and the serious consequences attending failure alike contributing to make its design and construction a matter demanding the best ability. The complexity of the problem has been greatly increased with the multiplication of cylinders and cranks which modern multiple expansion engines involve, and the magnitude, direction, and influence of the forces at work upon such a shaft constitute a factor of great uncertainty.

A paper upon this subject is contributed to a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* by Herr von Berling, of the Imperial shipyard at Kiel. It is a complete analysis of the various forces acting upon multiple crank shafts in actual service, the discussion being both graphical and analytical.

Considering the shaft first as a continuous girder, the manner in which any deflection between two bearings is transmitted to the portions between the other bearings is first discussed, after which the combined bending and twisting action of the cranks is taken into account, and compu-

tations made to show, not only the magnitude of the stresses induced in the shaft as a whole, but also the points of greatest stress, and therefore of greatest liability to breakage. The number and relation of cranks, as regards both angular position and longitudinal location on the shaft, are taken into account, computations being given for two cranks, either opposite or at right angles, as well as three and four cranks under conditions of actual practice.

The nature of the subject is such that only a general indication of the method of treatment can be given here, but the mathematical work is not complex, and the use of graphical diagrams render the application of the formulas easily intelligible, especially as worked-out examples are appended.

It is believed that an examination of the method which Herr von Berling has developed would, if generally applied, do much to diminish the number of shaft breakages at sea.

The Improvement of the Danube at Regensburg.

THE regulation of the Danube at and below the old imperial city of Regensburg, or, as it is sometimes called, Ratisbon, affords an excellent example of the general river-improvement work which is constantly being conducted throughout central Europe, and to which, as has been noted elsewhere, increasing attention is now being given. Incidentally the work at Regensburg shows the difficult conditions attending improvement works where old structures interfere with the introduction of what would otherwise be the best methods of reaching the desired end.

An official account by Herr Arthur Herbst of the work which has been done at Regensburg, is given, with illustrations and map in the *Oesterreichische Monatsschrift für den öffentlichen Baudienst*.

The Danube at Regensburg is divided into two branches, separated by islands known as the *obere* and *untere* Wörth, and, at the wide stretch where the gap between the two islands occurs, there is an old stone arch bridge, dating back to the twelfth century, and connecting the city

proper with a suburb called the "Stadt am Hof."

This old bridge doubtless was placed at the widest point, in accordance with the well-known mediæval practice, in order that the massive piers and short-span arches should oppose a minimum resistance to the flow of water at time of freshets; but at present the location of the bridge prevents the improvement of the river from being carried to a point higher up stream, so that the regulation of the channel has been limited to the stretch below the bridge.

A large portion of the work which has been done on this portion of the stream consists of a contraction of the channel, building out the banks at points where the river had spread to too great a width, and confining the channel to definite limits best suited for the maintenance of a navigable water-way.

The especial reason for this portion of the work was that the double curve in the river, below the city of Regensburg, causes a tendency to divert the channel, which thus closely approaches now one bank, now the other, giving insufficient room for navigation, and creating shoals on the opposite sides. This work was accompanied by the necessary dredging, and, after the channel had been once regulated, the current was so directed as to maintain

it. Interesting details of the methods of filling up the back shallows are illustrated, one being the filling of scows with stone in which pine trees were placed vertically with all the foliage on the bough, these scows being towed to the desired points and sunk. The weight of the stone retained the trees in position and made a network into which the dredged material from the channel was dumped, thus forming a bank not readily eroded by the current. At other points mattresses of fascines and brush work were used with gravel filling, the whole system, illustrated in the paper, forming an excellent example of river regulation works.

At the dock below Regensburg an excellent stone quay wall has been constructed, a foundation of piling having first been driven, upon which an outer timber coffer-dam wall was temporarily made, behind which a solid concrete permanent wall was built, giving for commercial purposes a river front well adapted to the needs of the city.

These works are noteworthy, not because of their magnitude or commercial value, but as an excellent example of the general river improvement going on in many parts of Europe in the interest of that system of cheap internal water-way merchandise transport the necessity of which is being felt more and more.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, in the original language, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of \$1.35. In ordering, care should be taken to give the number of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for \$2, forty for \$5, and one hundred for \$12.

This Coupon	will be received by us in payment for any 15 cent article catalogued in "The Engineering Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents; thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.
The Engineering Magazine, New York:	
Please send Article No. _____	to the following address: _____
Facsimile Not Good	

With a supply of these coupons on hand, no letter writing is required. Simply fill in the number and your address. A stamped envelope does the rest.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.

Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

- Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Engineer. *w.* London.
 Engineer. *s-m.* New York.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, Tenn.
 Engineering and Mining Journal. *w.* New York
 Engineering Journal. *s. an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
 Fire and Water. *w.* New York.
 Forester. *m.* Washington, D. C.
 Forum. *m.* New York.
 Foundry. *m.* Detroit, Mich.
 Gas Engineers' Mag. *m.* Birmingham, England.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Gunton's Magazine. *m.* New York.
 Harper's Weekly. *w.* New York.
 Heating and Ventilation. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago, Ill.
 Iron Age. *w.* New York.
 Iron and Coal Trades' Review. *w.* London.
 Iron & Steel Trades' Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco, Cal.
 Journal Franklin Institute. *m.* Phila., Pa.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *q.* New London, Conn.
 Journal Political Economy. *q.* Chicago, Ill.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kan.
 Locomotive. *m.* Hartford, Conn.
 Locomotive Engineering. *m.* New York.
 Locomotive Firemen's Mag. *m.* Peoria, Ill.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore, Md.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Master Steam Fitter. *m.* Chicago, Ill.
 Mechanical World. *w.* London.
 McClure's Magazine. *m.* New York.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, Pa.
 Mining and Sel. Press. *w.* San Francisco, Cal.
 Mining Industry and Review. *w.* Denver, Col.
 Mining Journal. *w.* London.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Monatschrift des Württ. Vereines für Baukunde,
 10 parts yearly. Stuttgart.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, Ind.
 National Builder. *m.* Chicago, Ill.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Physical Review. *b-m.* New York.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineer's Club. *q.* Phila., Pa.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago, Ill.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago, Ill.
 Railway & Engineering Review. *w.* Chicago, Ill.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revue de Mécanique. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Sanitarian. *m.* Brooklyn, N. Y.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerisches Bauzeitung. *w.* Zurich.
 Science. *w.* Lancaster, Pa.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Scientific Machinist. *s-m.* Cleveland, Ohio.
 Scribner's Magazine. *m.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, N. Y.
 Southern Architect. *m.* Atlanta, Ga.
 Stahl und Eisen. *s-m.* Dusseldorf.
 State's Duty. *m.* St. Louis, Mo.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, N. J.
 Stone. *m.* Chicago, Ill.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston, Mass.
 Trans. Assn. O. E. of Cornell Univ. Ithaca, N. Y.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago, Ill.
 Western Railway Club. Pro. Chicago, Ill.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, Conn.
 Zeitschrift für Lokomotivführer. *m.* Hannover.
 Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Accident.

An Erection Accident. Describes failure of roof trusses of the State Armory building at Newburg, N. Y. 600 w. Eng Rec—April 30, 1898. No. 19959.

Architectural Dangers.

Lessons from Fire and Panic. Thomas Blashill. Paper read at meeting of the Surveyors' Inst. at Manchester, Eng. Discusses points in construction tending to secure safety of the inmates. 7300 w. Builder—April 23, 1898. No. 20014 A.

Dome.

Erecting the Dome of the Rahway Reformatory. Illustrated description of construction of a metal dome 120 feet in diameter, 8 feet larger than that of St. Paul's, London. 1200 w. Eng Rec—May 14, 1898. No. 20215.

Domestic Architecture.

A Study of Domestic Architecture in the Eastern States of America in the year 1896. A. N. Paterson. Read at meeting of Royal Inst. of Brit. Arch'ts. Abstract. Describes various types, calling attention to special features due to climatic conditions, materials used and systems of heating. 1500 w. Arch, Lond—April 22, 1898. No. 20001 A.

Ecole des Beaux-Arts.

The Spirit of Design at the Ecole des Beaux-Arts. John Galen Howard. Presents some of the salient points of the scientific instruction, with the aim of forming a just idea of the province and influence of the school. 4000 w. Arch Rev—Vol V. No. III., 1898. No. 19965 F.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) A review of the present status of the work, with illustrations of some of the models of the buildings, and a plan of the area selected for the colonial exhibit. 2500 w. La Revue Technique—April 25, 1898. No. 20402 D.

Fire-Proof.

A New Fire-Proof Floor. Illustrated description of a new form of floor designed on the beam principle. The beams are made of "mac-kolite," the basis of the material being gypsum. 1000 w. Eng News—May 26, 1898. No. 20517.

Fire-Proof Construction and Prevention of Corrosion. William Sooy Smith. Considers the materials employed and the mode of construction of buildings, with a view to making them strong, safe and economical, and proof against destruction by fire and water; recommending a construction using "asbestos" as a covering and presenting its qualities. 3500 w. Jour W Soc of Engs—April, 1898. No. 20510 D.

Fire-Proofing of Warehouses. Frank B. Abbott. Discusses the means of protecting steel

framed buildings from corrosion and fire. Urges the surrounding every structural member with concrete, leaving no air spaces externally or internally. Discussion. 14000 w. Jour W Soc of Engs—April, 1898. No. 20511 D.

Some Notes upon the Struggle for Survival between Burnt-Clay Fire-Proofing and Its Newly Arisen Rivals. Dankmar Adler. Part first notes the pauses that are sure to come in the development of industrial progress, and comments on the wisest way to meet the pause now reached by the burnt-clay fire-protective coverings, suggesting a study of the damages inflicted on the material by fire and the means of prevention. 2000 w. Br Build—May, 1898. Serial. 1st part. No. 20512 C.

High Buildings.

The High Buildings of the Ancients. From the St. Louis *Globe-Democrat*. Interesting account of laws, regulating the height of Roman buildings, long before the Christian era. 3500 w. Am Arch—April 30, 1898. No. 19992.

Library.

Record and Library Building for the City of Cologne. (Archiv und Bibliothek der Stadt Köln.) Plans, photographic views and detailed description of the fine new building for the archives and city library. 3000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—May, 1898. No. 20437 D.

Mechanical Plants.

Mechanical Plants of Large Buildings. Dankmar Adler. Reviews the requirements for the satisfying of which mechanical appliances and apparatus are essential, the great improvements made in recent years, the educational development of the expert engineer, &c., with discussion. 8500 w. Jour W Soc of Engs—April, 1898. No. 20508 D.

Municipal Buildings.

The Mairies of Paris. Fernand Mazade. Description, with many illustrations, of these edifices, and criticisms showing that they are usually ill-adapted to the purpose they are intended to serve. 4200 w. Arch Rec—April-June, 1898. No. 20098 C.

Notes on the Construction of Town Buildings. Howard Chatfield Clarke. A paper taken as read at the Manchester (Eng.) meeting of the Surveyors' Inst. Considers these buildings from the points of view of construction, materials, and cost. 3300 w. Builder—April 30, 1898. No. 20152 A.

Police Station.

A New York City Police Station. Illustrates a building for a force of nearly 150 men, officers, calls, patrol stables, and other special features. 1800 w. Eng Rec—May 7, 1898. No. 20092.

Reconstruction.

Strengthening the Walls of a Theatre. Describes the reconstruction of bulging walls and decaying roof trusses of the Madison Street opera-house, Chicago. 600 w. Eng Rec—April 30, 1898. No. 19960.

Roofs.

Novel Roof Construction. Owen B. Maginnis. Illustrates and describes an unusual form of trussed roof. 800 w. *Ill Car & Build*—May 13, 1898. No. 20324 A.

HEATING AND VENTILATION.**Fan System.**

Heating and Ventilation of the Infirmary of the Indiana Reformatory, Jeffersonville, Ind. Illustrated description of a first-class fan system of heating and ventilation, which can be installed at small expense. Plans and data of the plant in the building named are given. 1100 w. *Heat & Ven*—May 15, 1898. No. 20365.

France.

The Application of Low Pressure Steam for the Heating of Dwelling-Houses and Public Buildings in France. An account of the introduction of this system of heating in France. 1100 w. *Dom Engng*—May, 1898. No. 20281 C.

Fuels.

The Working Value of Fuels. Thomas Fletcher. Reprinted from the *London Gas World*. Considers the heating of living rooms by coal gas and plant houses by coke fired boilers, where the ventilation is controlled, the figures being for average work. 1000 w. *Met Work*—May 7, 1898. No. 20084.

Furnace System.

An Efficient Furnace System. Illustrates an arrangement of a few risers to heat a number of rooms. 400 w. *Eng Rec*—May 21, 1898. No. 20317.

Greenhouse Heating.

Application of Heat to Greenhouse Structures. W. R. Beattie, in the *Columbus Horticultural Journal*. Describes a combination of steam and hot-water heating that the writer has found advantageous. 1300 w. *Met Work*—May 14, 1898. No. 20178.

Masonic Temple.

Heating of the Utica Masonic Temple. Illustrated description of a direct and indirect system in a 3-story and basement building. 1000 w. *Eng Rec*—May 21, 1898. No. 20316.

Post-Office.

Ventilation and Heating of the Omaha Post-Office. Illustrates the plant in a four-story public building covering 167 x 133 feet. Low-pressure exhaust steam is used, and a modified double-duct system is employed, with supplementary direct and direct-indirect radiation on the different floors. 1200 w. *Eng Rec*—May 7, 1898. No. 20093.

Railway Station.

Low Pressure Steam Heating Apparatus, Erie Railroad Passenger Station, Jamestown, N. Y. Plans showing the arrangement of the radiators, and the distribution of the surface in various parts of the building. Ill. 400 w. *Heat & Ven*—May 15, 1898. No. 20367.

School Heating.

Heating of the Roslyn, N. Y., School. Il-

lustrates a small plant on the low-pressure indirect gravity system with sufficient direct radiation to counteract the heat transmitted by the walls and windows. 600 w. *Eng Rec*—April 30, 1898. No. 19961.

Ventilation.

Ventilation of Buildings. R. C. Carpenter. The first of a series of articles which will describe applications of various methods as practiced in France thirty or thirty-five years ago, and also give historical references to various systems. 2300 w. *Heat & Ven*—May 15, 1898. Serial. 1st part. No. 20366.

Warm Air.

Heating Buildings by the Warm Air System. J. J. Blackmore. Describing the conditions and methods of the most advanced practice in warm air heating, both for residences and public buildings, with numerous illustrations. 3000 w. *Engineering Magazine*—June, 1898. No. 20477 B.

PLUMBING AND GAS FITTING.**Business Methods.**

How Should the Plumber Conduct his Business in Order to Make a Reasonable Profit? John J. Foy. Read at convention of Nat. Assn. of Plumbers, at San Antonio, Tex. On the changed conditions and advancement in this trade, the necessity of education and needed reforms. 1700 w. *San Plumb*—May 1, 1898. No. 20100.

Residence.

Plumbing in the Kunhardt Country Residence. Illustrates an elaborate installation for domestic supply, fire protection and drainage. 1600 w. *Eng Rec*—May 14, 1898. No. 20217.

Siphonage.

Recent Experiments in Trap Siphonage. William Paul Gerhard. An account of experiments made in Cologne, Germany, by Herr Unna, with the results. Ill. 4000 w. *Am Arch*—May 21, 1898. No. 20321.

MISCELLANY.**Aberdeen.**

The Architecture of Our Large Provincial Towns—Aberdeen. An illustrated description of very interesting architecture, with some information of the city. 7000 w. *Builder*—May 14, 1898. No. 20334 A.

Competitions.

The Morality and Economy of Competitions. H. B. Cresswell. Read before the British Architectural Assn. Considers the system detrimental to the best interests of architecture and to the profession of architects. 3000 w. *Arch*, Lond—April 29, 1898. No. 20150 A.

Contract Relations.

The Relations between the Purchaser, the Engineer, and the Manufacturer. William H. Bryan. Discusses the mutual obligations and responsibilities of the parties with especial reference to the relations of engineer and architect. 3500 w. *Am Soc of Mech Eng*s, No. 781—June, 1898. No. 20254 D.

Copyright.

Artistic Copyright—With Special Reference to Architects. Georges Harmand. The protection of copyright in architectural design, especially as it is regarded on the continent of Europe. 11400 w. Jour Roy Inst of Brit Arch'ts—April 9, 1898. No. 20175 B.

Gardening.

The Garden as an Adjunct to Architecture. R. Clipston Sturgis. Criticisms and suggestions relating to the treatment of grounds around dwellings. Ill. 4500 w. Arch Rev—Vol. V. No. III. 1898. No. 19964 F.

Government Architecture.

United States Government Architectural Work and Workers. Reviews the history of the United States government Department of Architecture, with the personnel and routine of workings. 7500 w. In Arch—April, 1898. No. 19985 D.

Heraldry.

Heraldic Drawing and Its Adaptation. J. D. Crace. Considers the qualities which should distinguish good heraldic drawing, presenting examples, and discussing their application to decorative effects. Also discussion. 6400 w. Jour Roy Inst of Brit Arch'ts—March 26, 1898. No. 20174 B.

Lighting.

Interior Lighting. (Reflected Lights, &c.) W. Eckstein. Read at meeting of the Architectural Assn., London. Discusses means of ob-

taining the best and most useful daylight, and gives much information of use to architects. Ill. 4800 w. Builder—May 14, 1898. No. 20335 A.

Monuments.

Preservation of Historic Monuments. Explains the control in Belgium over the demolition of ancient monuments or their repairs, when such are of a nature to change the style or character. 1800 w. Arch, Lond—May 6, 1898. No. 20244 A.

Preservation of Ancient Monuments. Gives the regulations in force in Sweden and Norway. 1700 w. Arch, Lond—April 22, 1898. No. 20002 A.

Preservation of Historic Monuments. There is in Austria no voluntary association for the protection of historic buildings, but the functions of such a society are undertaken by a commission. The protection given in Bavaria is also presented. 2200 w. Arch, Lond—April 29, 1898. No. 20151 A.

Review.

A Reminiscence of Architecture. A. A. P. Historical review of architectural remains in England, dating from the Conquest. 2300 w. Ill Car & Build—May 6, 1898. No. 20227 A.

William Morris.

The Art of William Morris. Russell Sturgis. Reviews a work on this subject by Aymar Vallance, and gives illustrations of his designs. 7500 w. Arch Rec—April, June, 1898. No. 20099 C.

CIVIL ENGINEERING.**BRIDGES.****Cantilever.**

Cantilever Bridge Over the Theiss River at Tokaj, Hungary. Abstract translation of description by the designer, Ö. J. Marstrand, as published in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*. Ill. 600 w. Eng. News—May 26, 1898. No. 20520.

Centering.

The Centering for the Arch over the River at Vienna. (Das Lehrgerüst für die Wienfluss-Einwölbung.) Details and photograph of a well designed timber centering of 70 feet span. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—April 29, 1898. No. 20433 B.

Coffer Dams.

Practical Points on Coffer-Dam Work. J. B. Gordon. The writer's experience in stopping leaks, with some of the difficulties he met in the work on the bridge between Staten Island and New Jersey. 1200 w. Stone—May, 1898. No. 20378 C.

Drawbridge.

The Design of a Modern Drawbridge. Andrews Allen. Presents the design of the Calumet River Draw, for the Calumet & Blue Island Ry. Co. Ill. 2800 w. Wis Engr—Jan., 1898. No. 20277 D.

East River Bridge.

The Brooklyn Anchorage of the New East River Bridge. Illustrated description of the plant and methods of construction of an anchorage 114 feet high, resting on a platform 158 x 177 feet. 2800 w. Eng Rec—May 14, 1898. No. 20210.

Metallic Bridges.

The Erection of Metallic Bridges. Frank P. McKibben. Considers the various methods of erecting different forms of metallic bridges. Illustrations and discussion. 9000 w. Jour Assn of Engng Soc's—March, 1898. No. 19977 C.

Reconstruction.

Reconstruction of the Chicago & Northwestern Bridge, Clinton, Iowa. Engravings showing the main features of the reconstruction of four fixed spans of the single-track bridge over the Mississippi, with account of the work. 900 w. R R Gaz—May 20, 1898. No. 20299.

Temporary Bridge.

The Temporary Vauxhall Bridge. Photographic views, plan and elevation of central girders, with brief notes. 500 w. Engr, Lond—May 13, 1898. No. 20353 A.

Viaduct.

The Rock Creek Masonry Bridge, Washing-

ton, D. C. Describes novel features of 1341-ft. arch viaduct, designed by G. S. Morison. 900 w. Eng Rec—April 30, 1898. No. 19954.

Working Stress.

The Determination of the Safe Working Stress for Railway Bridges of Wrought Iron and Steel. E. Herbert Stone. Compares and discusses six systems for giving approximately the safe working stress for wrought iron, with discussion of results for steel and related matters of interest. 11500 w. Pro Am Soc of Civ Engs—May, 1898. No. 20395 F.

CANALS, RIVERS AND HARBORS.

Asia.

The Rivers of Asia. E. A. Sibold. Part first gives information concerning the rivers of the Sistan basin. Map. 1600 w. Ind Engng—April 16, 1898. Serial. 1st part. No. 20290 D.

Banks.

Protection of River Banks. Robert Grimshaw. Illustrated account of how river banks in Germany are protected. 2200 w. Engr, N. Y.—May 2, 1898. No. 20660.

Dam.

Steel Dam at Ash Fork, Arizona. A. T. & S. F. Ry. Illustrated description of a dam 184 ft. long on top, consisting of a series of triangular steel frames, resting on concrete foundations, and carrying steel face plates on the upstream face. 2500 w. Eng News—May 12, 1898. No. 20155.

The Management of Non-Parallel Motion and Deficient Operating Head in Bear Trap Dams by Auxiliary Constructions. An examination of the reasons which led to the use of auxiliary power in the Chicago Drainage Canal bear trap and in the Marshall bear trap. 2500 w. Eng News—May 26, 1898. No. 20519.

The Marshall Automatic Movable Dam. Illustrated description of a dam belonging to the "bear-trap" type and its operation. 2000 w. Eng News—May 26, 1898. No. 20521.

The Use of the Trapezoidal Formula in the Study of the Resistance of Masonry Dams. (Sur la Légitimité de la Règle dite du Trapèze dans l'Étude de la Résistance des Barrages en Maçonnerie.) Maurice Lévy. A discussion of the extent to which the trapezoidal formula may safely be used, having reference to the failure of the Bouzey dam. 2500 w. Comptes Rendus—May 2, 1898. No. 20417 D.

Danube.

The Regulation of the Danube at Ratisbon. (Die Donau bei Regensburg.) A. Herbst. A general account of the improvement of the river by limiting the width of the channel, by dredging, and by the construction of new quay walls. 500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—May 1898. No. 20436 D.

Detritus.

Sea-Beaches and Sandbanks. Vaughan Cornish. Abstract of a paper read before the Royal Geographical Society. Research upon the processes which distribute the detritus which enters the sea at its margin, and upon the behavior of

the material distributed. Ill. 2000 w. Nature—May 12, 1898. No. 20326 A.

Drainage.

Drainage Plant of the Delta of the Niemen. (Installation de Dessèchement du Delta du Niemen.) Fully illustrated description of the electrically operated system of scoop wheels by use of which a large volume of water is lifted a moderate height, recovering nearly 45,000 acres of land. 3000 w. 1 plate. La Revue Technique—April 25, 1898. No. 20400 D.

Dredging.

The Improvement of the Mississippi River by Dredging. H. St. L. Coppée. A fully illustrated account of the work of the Government engineers in removing bars, dredging channels, and regulating the navigation of the Mississippi. 4500 w. Engineering Magazine—June, 1898. No. 20480 B.

U. S. Government Hydraulic Dredges. Illustrates suction and jet dredges used on the Mississippi. 900 w. Eng Rec—May 14, 1898. No. 20211.

Flow.

The Flow of Water. H. S. Hele-Shaw. Illustrated account of experiments made to investigate the flow of water. 1500 w. Nature—May 12, 1898. No. 20325 A.

Levees.

The Levees of the Red River in Louisiana. F. M. Kerr. Abstract from paper presented to the Louisiana Engng. Soc., reviewing the past conditions of this valley, the influences at work and the progress made in protecting the land from overflow. 1800 w. Eng News—May 12, 1898. No. 20160.

Lighthouses.

Recent Progress in Coast Illumination. (Les Progrès Récents de l'Eclairage des Côtes.) Jean Rey. An illustrated account of the development of modern systems of lighting, from the compound lenses of Fresnel to the latest "lightning flash" method. 12000 w. Bulletin de la Société d'Encour—April, 1898. No. 20410 G.

The New Electric Lighthouse of Penmarch-Eckmühl. (Finisterre.) C. Du Riche Preller. Illustrates and describes the distinctive features of this lighthouse of the Bay of Biscay. 1500 w. Engng—May 6, 1898. Serial. 1st part. No. 20229 A.

Madras.

Advance Madras! An account of harbor improvements in this part of India which have been carried out in the face of great natural difficulties. 1000 w. Ind Engng—April 2, 1898. No. 20079 D.

Madras Harbor. Discussion of the improvement in harbor facilities. Part first considers the boat basin project. 3300 w. Ind Engng—April 16, 1898. Serial. 1st part. No. 20291 D.

Mountain Streams.

The Regulation of Mountain Streams. (Ueber die Regulierung von Gebirgswässern.) F. Wang. Describing the methods used in Galicia, Bohemia, and the Tyrol for the protection of

the banks of mountain streams from erosion in times of overflow. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—May, 1898. No. 20438 D.

Nicaragua Canal.

The Nicaragua Canal Enterprise. William Ludlow. Extract from article in Harper's Magazine for May, discussing the "Trans-Isthmian Canal Problem." 1400 w. Eng News—May 5, 1898. No. 20074.

Ship Canal.

A Ship Canal to the Sea. H. S. Canby. Discusses the question of transportation, favoring the construction of a ship canal, and considering the new lock invented by Chauncey N. Dutton. 2000 w. Yale Sci M—April, 1898. No. 20035 C.

On the Great Lakes. F. W. Fitzpatrick. Illustrated presentation of the magnitude of the Great Lakes and their commerce. 3700 w. Cos—May, 1898. No. 20096.

IRRIGATION.

Barrage.

Special Repairs to the Barrage. W. E. Gars-tin. From the Administration Report of the Irrigation Department, Egypt. Particulars regarding the operation of stock-ramming and cement-grouting as carried out on the Nile Barrages. 3800 w. Ind Engng—April 9, 1898. No. 20187 D.

Mexico.

Canal Irrigation in Mexico. Hunter Morrison. Explains the system of the Tlahualilo company of Mexico, the difficulties in the accomplishment of the work, the administration and operation. 1700 w. Yale Sci M—May, 1898. No. 20266 C.

Seepage.

The Effect of Temperature on the Seepage of Water from Irrigation Canals. A collection of information from various sources, bearing upon the losses of water by absorption, evaporation, &c. 1500 w. Eng News—May 12, 1898. No. 20157.

MISCELLANY.

Beams.

Beams of Materials of Variable Coefficients of Deformation. (Träger aus Materialien von Veränderlichem Formänderungs-Coefficienten). Josef Anton Spitzer. With a special discussion of the conditions immediately preceding the instant of rupture. Two articles. 1 plate. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 29, May 6, 1898. No. 20432 each B.

Cement.

Comparison of American and Foreign Portland Cements. W. W. Maclay. Comments on methods of testing and quotations from those who are considered among the highest authorities on the subject. 2200 w. Munic Engng—May, 1898. No. 20030 C.

Improved Portland Cement. John W. Dickinson. Explains what Portland cement is, and the essentials of a perfect product, showing the great advance that has been made by the Amer-

ican manufacturer, with report of comparative tests, and general discussion. 5500 w. Jour W Soc of Engs—April, 1898. No. 20509 D.

The Candlot Oscillating Grate for Cement Kilns. Frederick H. Lewis. Illustrates a grate, used in France, for improving the draft and preventing balling in shaft kilns. 400 w. Eng Rec—May 21, 1898. No. 20312.

The Standardization of Cement Testing. Editorial comment on the questions submitted by the Am. Soc. of Civ. Engs. discussing the merits of the enterprise and the value of the steps being taken for its accomplishment. 2500 w. Engr, Lond—May 13, 1898. No. 20350 A.

Columns.

An Investigation of the Strength of Columns, Leading to Some New Formulas. Carl G. Barth. Submits a new and purely rational formula for the proper working load on a column, and the arguments sustaining it. 4800 w. Jour Assn of Bngng Socs—April, 1898. No. 20505 C.

Contracting.

The Right to Withdraw Erroneous Bids. Editorial review of decision of U. S. Circuit Court affirming contractor's right to withdraw bids containing manifest errors, before contract is made. 900 w. Eng Rec—April 30, 1898. No. 19952.

Contract Relations.

See Architecture and Building, Miscellany.

Lime.

Lime, Mortar and Cement. Their Composition and Analyses. W. J. Dibdin. Part first deals with the characteristics of various limes. 1500 w. San Rec—April 29, 1898. Serial. 1st part. No. 20085 A.

Office Methods.

Index System in City Surveyor's Office, Hartford, Conn. Frederick L. Ford. Illustrates the card index for field notes and drawings. 900 w. Eng Rec—May 7, 1898. No. 20091.

Painting.

Testing Oil Paints on Iron. Dr. H. Lols-ner. Gives a description of the testing method employed by the writer, which is simple and yet may be called a crucial one. 1000 w. R R Car Jour—May, 1898. No. 20117.

Pile-Driving.

Some Instances of Piles and Pile-Driving, New and Old. Horace J. Howe. A record of facts and experiments from the experience of the writer, with quotations from many authorities, and discussion. 2350 w. Jour Assn of Engng Socs—April, 1898. No. 20506 C.

Projects.

Unprofitable Engineering Projects in Western America. A. G. Allan. Showing the folly of investing in any scheme without the fullest investigation. Both good and bad schemes are discussed and illustrated and the wisdom of obtaining reliable information emphasized. 3500 w. Engineering Magazine—June, 1898. No. 20478 B.

Roads.

Road Materials and Construction. W. M.

Watson. Reviews various systems of construction, referring to the old Roman roads, and later methods used by Macadam and others. 1300 w. *Can Eng*—May, 1898. No. 20193.

Surveying.

State Boundaries. Abstract from a paper by Henry B. Wood, read before the Boston Soc. of Civ. Engs. Description of township and state boundary surveys in Massachusetts. 2500 w. *Eng Rec*—May 14, 1898. No. 20212.

Tacheograph.

The Ziegler-Hager Tacheograph. Illustrated description of a surveying instrument, the chief merits being that horizontal distances and vertical heights are read off at the same time, that there are no calculations, that the instru-

ment checks itself, and that the operations require very little time and skill. 800 w. *Engng*—May 6, 1898. No. 20230 A.

Triangulation.

The Triangulation of Bronx Borough, New York City. William S. Dalrymple. Description of the work, with map. 2000 w. *Eng News*—May 19, 1898. No. 20270.

Wood-Borers.

Marine Wood-Borers. Charles H. Snow. Illustrated description of the animals and their manner of working, their reproduction and development, some of the methods of protection which have proved most successful, &c. 12000 w. *Pro Am Soc of Civ Engs*—May, 1898. No. 20396 F.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Bicycles.

Reports on Bicycles. Information in the interests of trade concerning Norway, China, and Korea. 2000 w. *Cons Repts*, No. 125—May 26, 1898. No. 20385 D.

British Empire.

The British Empire: Its Resources and Its Future. John Lowles. A survey of the British Empire, showing the progress of the colonies, and containing interesting information of the products, resources and future prospects. Discussion. 13300 w. *Jour Soc of Arts*—April 22, 1898. No. 19974 A.

Cape Colony.

Commercial Conditions in Cape Colony. Concerning dock facilities, freight rates, how to sell goods in South Africa, openings for trade, labor, &c. 1800 w. *Cons Repts*, No. 119—May 19, 1898. No. 20265 D.

China.

Opening of Inland Water Routes in China. Extract from a Shanghai journal, on the consent of the government to admit foreign and native steamers to all inland waters, and the effect it will have on trade. 1100 w. *Cons Repts*, No. 121—May 21, 1898. No. 20318 D.

The Foreign Trade of China in 1897. Account taken from the Returns of Trade drawn up by the Imperial Maritime Customs. 1600 w. *Bd of Trd Jour*—May, 1898. No. 20387 A.

Cuba.

Future Industrial Opportunities in Cuba. Wilfrid Skaife. A discussion of the commercial, manufacturing, and industrial possibilities of the island under a secure and stable government. 3500 w. *Engineering Magazine*—June, 1898. No. 20471 B.

Egypt.

The Development of British Trade with Egypt. Information from the Annual Report of the British Chamber of Commerce of Egypt for 1897, containing many suggestions for retaining and advancing trade in Egypt. 2800 w. *Bd of Trd Jour*—May, 1898. No. 20388 A.

Guatemala.

Guatemala Trade-Mark and Patent Laws. A copy of the principal articles of the new laws. 4200 w. *Bul of Bureau of Am Repts*—April, 1898. No. 20177 C.

Industrial Relations.

Possibilities of the Present Industrial System. Paul Monroe. Illustrated description of the National Cash Register Factory at Dayton, Ohio, and its methods, based upon inspection and conversations with employes. 6000 w. *Am Jour of Soc*—May, 1898. No. 20201 D.

Japan.

Foreign Trade of Japan in 1897. Facts showing remarkable increase and the tendency of Japan to become a manufacturing country. 700 w. *Bd of Trd Jour*—May, 1898. No. 20392 A.

Japan as a Market. W. R. Thompson. Reviewing the opportunities for trade and the chances for American manufactures. 1000 w. *Mfrs Rec*—May 27, 1898. No. 20397.

The Foreign Trade of Japan for 1897. Figures taken from the *Japan Weekly Mail*, which present the aspects to which the Japanese attach the most importance. 600 w. *Engng*—May 6, 1898. No. 20232 A.

Limited Liability.

The 'Limited Company' Craze. S. F. Van Oss. Reviews some of the influences on commercial efficiency and business morality and the economic effects. 6800 w. *Nineteenth Cent*—May, 1898. No. 20200 D.

Madagascar.

The Trading Ports of Madagascar. Information concerning the principal trading ports of the island, communication by steamer, &c. 2000 w. *Bd of Trd Jour*—May, 1898. No. 20391 A.

Oriental Trade.

Notes from the Orient. Extract from a letter to Rogers, Brown & Co., written by their representative in Yokohama, Japan, explaining the difficulties in the way of trade, the methods of work there, and other matters of interest, especially to the iron trade. Ill. 3500 w. *Foundry*—May, 1898. No. 20220.

Philippines.

The Philippine Islands. Information regarding the area, population, exports and general trade. 1800 w. Cons Repts, No. 107—May 7, 1898. No. 20077 D.

Trade and Industry of the Philippines. Information with regard to the economic condition of these islands, taken from the most recent reports of the British Consular officials at Manila and other ports. 700 w. Bd of Trd Jour—May, 1898. No. 20389 A.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Table showing fluctuations in quotations from Oct. 1, 1895, to May 1, 1898, with remarks on the "spring rise" in prices. 4800 w. Bradstreet's—May 7, 1898. No. 20081.

San Jose Scale.

German Restrictions on United States Fruit. Report of the decree controlling the admission of live plants, to prevent the spread of San José scale. 600 w. Cons Repts, No. 111—May 11, 1898. No. 20163 D.

Tariff.

Tariff Changes and Customs Regulations. Russia, France, Portugal, Spain, Italy, Chile, United States, Guatemala, Peru, Canada, and British Guiana. 4800 w. Bd of Trd Jour—May, 1898. No. 20393 A.

Trade-Marks.

Trade-Marks in Hungary. A translation of the rules concerning the registration of trade-marks now in force in Hungary. 600 w. Cons Repts, No. 125—May 26, 1898. No. 20386 D.

Trade Statistics.

British and German Trade in 1897. A comparison of the leading branches of trade of both countries and their relative development. 1600 w. Engng—April 22, 1898. No. 20016 A.

Water-Ways.

The Development of American Waterways, and their Influence upon European Exports. (Die Entwicklung der Nordamerikanischen Wasserstrassen und deren Rückwirkung auf den Export nach Europa.) An address by Herr Rudolf Ritter von Gunesch, showing the influence which cheap water-carriage will have upon competition, and urging the importance of internal waterways in central Europe. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—April 15, 22, 1898. No. 20430 each B.

West Indies.

Cuba and Puerto Rico. Summary by the Bureau of Foreign Commerce, which will appear in the Review of the World's Commerce, 1896-7, printed in advance in response to a demand for information concerning the Spanish West Indies. 7500 w. Cons Repts, No. 117—May 17, 1898. No. 20264 D.

Internal Resources of the West Indies. H. Guzman. Information concerning the agricultural products, ports, trade with the United States, and the importance of the reconstruction of the U. S. merchant marine. 2800 w. Bul

of Bureau of Am Rep—April, 1897. No. 20-176 C.

Wharfage.

Reduction of Wharfage Dues in France. Reports a new law, supplemental to the one that went into effect Dec. 31, which is designed to extend the advantages of a reduction of wharfage to those vessels unfavorably affected by the previous law. 800 w. Cons Repts, No. 118—May 18, 1898. No. 20263 D.

CURRENCY AND FINANCE.**India.**

India and Her Currency. Edward Sassoon. Reviews the history of the causes that led to the closing of the mints in India, and the monetary affairs from that time, discussing the policy pursued, various phases of the question, the difficulties and the effects. 10000 w. Jour Soc of Arts—May 13, 1898. No. 20329 A.

The Indian Currency Commission. W. R. Lawson. A discussion of the various sides of the currency question and the points to be brought before the commission. 6800 w. Bankers' Mag, London—May, 1898. No. 20504 A.

Japanese Investments.

Foreign Capital and Japanese Investments. Sets forth the adverse circumstances and conditions affecting commercial speculations in Japan. 1800 w. Engr, Lond—April 22, 1898. No. 20025 A.

LABOR.**Compensation Act.**

The Cost of Insurance under the Workmen's Compensation Act. Discussing the effect of this act which will be inaugurated in England on July 1st, especially as it bears on the gas industry, indicating how the insurance company's view of the subject has been formed. 2000 w. Jour Gas Lgt—May 17, 1898. No. 20383 A.

Invention.

Does Invention Lessen Employment? Remarks on information from the Report of the Commissioner of Patents for 1897, showing that invention increases employment. 2500 w. Gunton's Mag—May, 1898. No. 20111 C.

Machinery.

Men and Machinery. Starr Hoyt Nichols. Tending to show that the effect of machinery instead of injuring workmen and lessening their opportunities, is really the deliverer of mankind from evil and poverty, and tends to the general welfare. 3000 w. N Am Rev—May, 1898. No. 19981 D.

Municipal Ownership.

See Municipal Engineering, Gas Supply.

Strike.

South Wales Colliers' Strike. A statement conveying the views of the employers in the Monmouthshire and South Wales Coal-owners' Assn., on the strike of colliery workmen. 2700 w. Engng—April 29, 1898. No. 20140 A.

The Coal Strike. Statement of affairs relating to the coal strike in Wales, reporting disorganization amongst the colliers, and the lack of effective leaders. 2300 w. Engr, Lond—April 22, 1898. No. 20027 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Chromium.

The Electromotive Properties of Chromium. (Ueber das Elektromotorische Verhalten des Chroms.) A paper by Dr. Hittorf before the Leipzig meeting of the Electrochemical Society, showing the different electrical properties possessed by chromium under different conditions, 5000 w. Zeitschr Elektrochemie—May 5, 1898. No. 20458 H.

Electro Chemistry.

The Electro-Chemical Industries of England. John B. C. Kershaw. Part first gives a review of the progress made in the last twenty years, with views and remarks concerning the Castner-Kellner Alkali Works, at Weston Point, Eng. 1200 w. Elec, N. Y.—May 18, 1898. Serial. 1st part. No. 20285.

The Relation of Chemistry to Electrical Engineering. C. Fred Burgess. The importance of the science of electro-chemistry, and the close relation and important developments to be looked for in the near future. 2700 w. Wis Engr—Jan., 1898. No. 20276 D.

Electrolysis.

Hydrolytic and Electrolytic Dissociation. (Ueber Hydrolytische und Electrolytische Dissoziation.) Dr. G. Platner. A general review of preceding investigations, together with the author's own results in the electrical dissociation of solutions of salts, considered from a chemical point of view. 2000 w. Elektrochemische Zeitschr—May 1, 1898. No. 20459 H.

Notes on the Electrolysis of Chloride of Calcium Solutions. (Beitrag zur Kenntnis der Elektrolyse von Chlorcalcium-Lösungen.) H. Bischoff and F. Foerster. A full account of experimental investigations, using different currents and solutions. 4000 w. Zeitschr f Elektrochemie—April 20, 1898. No. 20457 H.

Electrolytic Soda.

The Hargreaves-Bird Electrolytic Soda Process. Illustrated description of apparatus and process. 1200 w. Eng & Min Jour—May 21, 1898. No. 20323.

Metallic Oxids.

Electrolytic Production of Oxygen Compounds of the Metals. Experiments showing that considerable economy in working can be effected in many industrial processes by care in the choice of electrodes and in the composition and density of the electrolyte. 1100 w. Elect'n, Lond—April 29, 1898. No. 20148 A.

LIGHTING.

Carbons.

Electric Light Carbons. (Kohlen für Electricches Licht.) Francis Jehl. Describing the various processes used for making electric light carbons, and the successive improvements which have been made. 1800 w. Der Electro-Techniker—April 30, 1898. No. 20463 B.

Efficiency.

The Real Meaning of Incandescent Lamp

Efficiency. Francis W. Willcox. An explanation of the terms and the basis for estimating the efficiency. 1800 w. Elec Wld—May 14, 1898. No. 20181.

Enclosed Arc.

The Jandus Lamp. (Die Jandus-Lampe.) Report of tests upon the Berlin-Frankfort railway giving photometric results of the Jandus enclosed arc. 1200 w. Der Electro-Techniker—April 30, 1898. No. 20464 B.

Filaments.

Carbonization of Filaments by Electricity. L. S. Powell. Describes an electric method devised for this purpose by the writer, with account of some experiments made to test its practicability, and suggestions for further investigations. 2700 w. Elec Rev, Lond—May 13, 1898. No. 20344 A.

Lamps.

Trimming and Cleaning of Enclosed Arc Lamps. J. H. Hallberg. Presents the importance of this work as affecting the efficiency and suggests a system for doing it. 1300 w. Elec Rev, N. Y.—May 11, 1898. No. 20095.

Lighthouse.

See Civil Engineering, Harbors.

Lighting Effects.

Electric Lighting as Applied to Architecture. T. Ekin. Read at meeting of the Architectural Assn., London. Considers the lighting of buildings by the incandescent electric lamp, dealing with the distribution, the artistic effect, wiring, &c. 2300 w. Arch, Lond—May 13, 1898. No. 20336 A.

Lighting Plant.

The Electric Lighting Plant of the University of Michigan. Henry S. Carhart. Brief illustrated description of interesting features. 1100 w. Elec Wld—May 7, 1898. No. 20061.

Meters.

The Care and Testing of Alternating Current Recording Meters. R. H. Sterling. Deals with the Shallenberger type of the recording ampere-hour meter for alternating current. Ill. 2000 w. An Elect'n—May, 1898. No. 19970.

Municipal Lighting.

Municipal Electric Lighting.—A Reply to Prof. Commons. Horatio A. Foster. The writer favors private ownership, and defends his arguments, discussing opinions advanced by the writer named. 2500 w. Elec Eng, N. Y.—May 12, 1898. No. 20168.

Resistances.

Commercial Forms of Electrical Resistances. L. B. Atkinson. Reviews the various types of electrical resistances used on light and power circuits, with special reference to a new material, "relugite." Ill. 3000 w. Elect'n, Lond—April 22, 1898. No. 20000 A.

Safety Attachment.

Protection for Edison Three-wire and Other Balanced Systems of Electrical Distribution.

Eustace Oxley. Explains the disastrous results that may follow the blowing of the neutral fuse, and describes and illustrates a simple safety attachment for a three-pole switch devised by the writer. 1400 w. Elec Eng, N. Y.—May 5, 1898. No. 20047.

Shades.

Conical and Spherical Shades. I. C. Thompson. Gives results of experiments made for the purpose of comparison. 910 w. Elec Eng, N. Y.—May 12, 1898. No. 20171.

Transformers.

Transformers v. Dynamos. Editorial comment on progress in England in electric lighting, with consideration of whether it is better to generate currents of high potential with a dynamo and transmit them direct, or to generate low-tension currents, throw them up with a transformer, and then transmit them. Favors the high-pressure dynamo. 1800 w. Engr, Lond—May 13, 1898. No. 20354 A.

Wimbledon, Eng.

The Wimbledon Electric Lighting Scheme. A. H. Preece. Read at meeting of the Incorporated Assn. of Municipal and County Engs. Description of the system that has been adopted, plant, mains, cost, etc. 2500 w. Elec Eng, Lond—May 13, 1898. No. 20338 A.

Wiring.

A Mechanical Computer of Fall of Potential. William Hand Brower, Jr. Describes a simple mechanical device for the solution of wiring problems, particularly convenient in calculations of conductor systems supplying current to movable receivers, or where the current demanded by fixed receivers may vary. 1700 w. Elec Wld—May 21, 1898. No. 20268.

"Free" and "Easy" Payment Systems of House Wiring. V. Zingler. Sets forth the scheme of John H. Rider to secure easy payment and compares it with the alternative scheme of the National Electric Free Wiring Co. 1500 w. Elec Rev, Lond—April 22, 1898. Serial. 1st part. No. 20006 A.

POWER.

Armature Reactions.

Armature Reactions in a Continuous Current Dynamo. C. A. Bessey. Reports results of a study of armature reactions, made at the Univ. of Nebraska. 500 w. Elec Eng, N. Y.—May 12, 1898. No. 20169.

Brush Holders.

Carbon Brush holders. Ernest Kilburn Scott. Gives a few of the rules which govern the application of carbon brushes, and also describes some of the leading types. Ill. 1200 w. Elec Rev, Lond—April 22, 1898. Serial. 1st part. No. 20012 A.

Combination Plant.

Continuous and Three Phase Current Plant. (Gleichstrom-Drehstrom-Speicheranlage.) The plant is installed in Hamburg warehouses, the three-phase current being used for motors, and the continuous current in connection with accumulators. 1200 w. Elektrotech Zeitschr—April 21, 1898. No. 20451 B.

Commutation.

Experiments in Commutation in Dynamos and Motors. W. H. Everett, and A. H. Peake. A short account of work in this field carried out in the electrotechnical laboratory of University College, Nottingham. Ill. 1500 w. Elect'n, Lond—April 22, 1898. No. 19999 A.

Cranes.

Electric Cranes. J. G. Statter. Abstract of a paper read before the Northern Soc. of Elec. Engs., England. Considers the lifting and transportation of loads by electrical energy, and the belt system. Also editorial. Ill. 6000 w. Elect'n, Lond—April 22, 1898. No. 19998 A.

Distribution.

Some of the Economic and Practical Aspects of Electrical Power Distribution in Factories. H. A. Mavor. Abstract of a paper read before the Inst. of Engs. & Shipbuilders. Considers factories where the power required is upward to 50 h. p., and where it is produced on the consumer's premises. 2300 w. Ir & Coal Trds Rev—April 29, 1898. No. 20126 A.

Dynamos.

Dynamo Troubles. Percy Donville. Read before the Hamilton Assn., C. A. S. E. Some points which should be considered in placing and caring for dynamos and motors. 2500 w. Mines & Min—May, 1898. No. 20064 C.

Efficiency.

Measurement of the Efficiency of Continuous Current Electric Machines of all Powers. P. Dupuy, in *L'Eclairage Electrique*. A method of determining the efficiency which necessitates the use of two similar machines. 500 w. Elec Rev, Lond—April 22, 1898. No. 20011 A.

Electrical Plant.

Electrical Plant of Macdonald Engineering Building, McGill University, Montreal. Illustrated description of this plant which has been extensively enlarged and altered. 1200 w. Can Elec News—May, 1898. No. 20082.

Electric Energy.

The Cost of Electric Energy. Editorial discussion of the subject, referring to information in paper of Robert Hammond. 2000 w. Engng—April 29, 1898. No. 20141 A.

The Cost of Generation and Distribution of Electrical Energy. Robert Hammond. Full paper read before the Inst. of Elec Engs., London. Discussion of the subject presenting a summary of the returns of undertakings in the United Kingdom. 55000 w. Pamphlet—British Inst. of Elec Engs. No. 20162 G.

The Cost of Generation and Distribution of Electrical Energy. Abstract of discussion by members of the Inst. of Elec. Engs. in connection with Mr. Hammond's paper. 7000 w. Elect'n, Lond—April 29, 1898. No. 20147 A.

The Distribution of Electrical Energy in Paris. J. Laffargue. Reprint of an article appearing in the Paris supplement of the *Contract Journal*. Part first reviews the conditions, giving map showing the distribution and positions of sections and considers the various networks. Ill. 1300 w. Elec Eng, Lond—April 29, 1898. Serial. 1st part. No. 20144 A.

The Distribution of Electrical Energy in Germany. J. Laffargue. Abstract of paper read before the Société Internationale des Electriciens. Gives general information with examination of some of the stations. 2300 w. Elec Rev, Lond—April 29, 1898. No. 20153 A.

Electric Mining.

See Mining and Metallurgy, Mining.

Flywheel-Dynamos.

Patin's New Flywheel-Dynamo. L. Bayly. Illustrated description. 800 w. Elec Rev, N. Y.—May 4, 1898. No. 20055.

Induction.

The Induction Motor. Alfred E. Wiener. The principles of the rotary field are clearly and accurately explained without the aid of mathematics. Ill. 1400 w. Am Elect'n—May, 1898. No. 19967.

Interrupter.

A New Interrupter for Induction Coils. V. Cremieu. Note presented to the Académie des Sciences. Illustrated description of apparatus for overcoming the inconveniences arising from the induced electromotive forces, of opposite nature, not being equal in value. 500 w. Elec Rev, Lond—April 29, 1898. No. 20154 A.

Interruptions.

The Prevention of Interruptions to Electricity Supply. Leonard Andrews. Read before the Inst of Elec. Engs., England. Discussing the causes and needed improvements, to guarantee an absolutely constant supply to every one, explaining the way the problem has been solved at Hastings. Ill. 4800 w. Elect'n, Lond—May 6, 1898. No. 20246 A.

Mining Motor.

See Mining and Metallurgy, Mining.

Motor.

A Universal Motor and Dynamo. Description, with working drawings, of a combined direct-current dynamo, alternator and rotary converter. 3200 w. Am Elect'n—May, 1898. No. 19969.

Single Phase Induction Motor. Charles Proteus Steinmetz. Considers load and speed curves; starting devices of various forms are investigated and the effect they have upon the action of the motor. Discussion. 18500 w. Trans Am Inst of Elec Engs—Feb., 1899. No. 19950 D.

Power Companies.

Electric Power Companies and Their Relation to Municipalities. Abstract of an address by Albion E. Long, delivered at Purdue University. Considers the relation of the company to the station producing the current and to the public. Does not approve municipal ownership. 1800 w. St Ry Rev—May 15, 1898. No. 20206 C.

Power Plant.

A Pacific Coast Power and Light Station—Los Angeles Street Railway Power Plant. Illustrated detailed description. 2000 w. Power—May, 1898. No. 20052.

Power Station.

The Hunt Power Station, Cincinnati, Ohio.

Bert L. Baldwin. Illustrated description of a plant, showing what can be done in the way of remodeling an old plant. 1700 w. St Ry Jour—May, 1898. No. 20038 D.

Standardizing.

The Standardizing of Generators, Motors and Transformers. A discussion, opened by E. W. Rice, Jr. Also discussion at Chicago. 15000 w. Trans Am Inst of Elec Engs—Feb., 1898. No. 19949 D.

Station Records.

Electric Light and Power Station Records. Illustrates and describes Macrea's apparatus and its operation. 1200 w. Elec Eng, N. Y.—May 5, 1898. No. 20046.

Three-Phase Motors.

The Application of Three-Phase Currents. (Application des Courants Triphasés.) Description of the installation of a series of three-phase current motors at the Pernot biscuit bakery at Dijon. 1200 w. Le Génie Civil—April 23, 1898. No. 20405 D.

Transmission.

Erecting a High Voltage Transmission Line. S. H. Dailey. First half of an article, the laying out of the line and gaining of poles being treated. Ill. 2400 w. Am Elect'n—May 1898. Serial. 1st part. No. 19968.

Water-Power Plant.

St. Anthony Falls Water-Power Plant. Illustrated description of the large plant for furnishing power to the electric railways of St. Paul and Minneapolis. 3500 w. Am Elect'n—May, 1898. No. 19966.

TELEGRAPHY AND TELEPHONY.

Cables.

Electric Cables with Dry-Air Circulation. A. Barbarat. Abstract of a paper read before the Société Internationale des Electriciens. Describes the system of telephone cables employed at present in Paris. The telephone network is entirely underground, and the cables are ordered with paper insulation and dry-air circulation. 800 w. Elect'n, Lond—May 13, 1898. No. 20342 A.

Exchanges.

Large Opposition Telephone Exchanges. Considers the situation at St. Louis, Mo., as it existed before the entrance of the opposition company, and contrasts its financial features with the record of Detroit's exchange. 4800 w. Elec Engng—May 15, 1898. No. 20219.

Receiver.

Morse Receiver for the Argentine Telegraph System. (Morse Farbschreiber der Argentinischen Telegraphenverwaltung.) Describing the Tribelhorn receiver with automatic release, as used in Argentina. 1500 w. Elektrotech Zeitschr—April 28, 1898. No. 20453 B.

Space Telegraphy.

Automatic Receiver for Hertzian Wireless Telegraphy. (Poste Récepteur Pour la Télégraphie Hertzienne sans Fils.) E. Ducretet. A receiver to be used in connection with the Branly Coherer, recording the message in

Morse signals on paper strip. 1000 w. *Comptes Rendus*—May 2, 1898. No. 20419 D.

Some Facts about Wireless Telegraphy. Relates to the experiments that are being conducted in England by Mr. Marconi, with reference to work in other countries. 2300 w. *Elec Rev*, Lond—April 22, 1898. No. 20009 A.

Wireless Telegraphy. An editorial calling attention to some of the practical difficulties involved. 1400 w. *Elect'n*, Lond—May 13, 1898. No. 20341 A.

Vision.

Electric Vision at a Distance. (*Der Elektrischer Fernseher*.) A description of the apparatus of the Pole, Szczepanik, which is claimed to enable the electrical transmission of visual images to be accomplished. 2000 w. *Die Elektrizität*—April 16, 1898. No. 20461 D.

MISCELLANY.

Accumulators.

The Making of Lathanode Accumulators. Illustrated description of the process of making lithanode cells. 900 w. *Elec Rev*, Lond—May 13, 1898. No. 20345 A.

The Ribbe Accumulator. (*Der Ribbe-Akkumulator*.) This new storage battery is constructed with perforated celluloid plates to support the paste in such a manner as to render the cells much less liable to injury by transportation or rough handling. 1200 w. *Elektrochemische Zeitschr*—May 1, 1898. No. 20460 H.

Alloys.

Electrical Alloys. Rollo Appleyard. A summary of the investigations made in Germany to determine the mechanical and electrical permanence of the cheaper alloys used for resistance coils. 1200 w. *Elec Rev*, Lond—April 22, 1898. Serial. 1st part. No. 20008 A.

Alternate Currents.

Alternate Current Workings. Donald H. Fry. The first of a series of articles aiming to make clear some points in alternating currents not generally understood, and to show wherein they differ from direct currents. Ill. 3000 w. *Jour of Elec*—April, 1898. No. 20516.

On a Simple Approximate Method of Determining the Harmonic Components of a Graphically Given Complex Harmonic Wave. Edwin J. Houston and A. E. Kennelly. A method serviceable to engineers rather than to mathematicians, for finding the amplitudes of the harmonic components in an alternating current wave. 1200 w. *Elec Wld*—May 14, 1898. No. 20180.

Electric Furnaces.

Electric Smelting Furnaces. (*Elektrische Schmelzöfen*.) C. Häussermann. A general descriptive article of the various forms of electric furnaces which have been used up to the present time. 3000 w. *Zeitschr d Ver Deutscher Ing*—April 16, 1898. No. 20422 D.

Exhibition.

Events at the Electrical Exhibition. An account of the exhibition at Madison Sq. Garden, New York, with illustrated description of many of the exhibits. 9500 w. *Elec Eng*, N. Y.—May 12, 1898. No. 20173.

Opening of the Electrical Exhibition. An account of the opening, the features of interest and exhibits, giving floor plan. 2100 w. *Elec*, N. Y.—May 4, 1898. No. 20043.

The Second New York Electrical Exhibition. Editorial review of this exhibition, considering it very creditable. 900 w. *Eng News*—May 12, 1898. No. 20158.

Frictional Electricity.

The Mechanics of Frictional Electricity. (*Die Mechanik der Reibungselektricität*.) J. F. Weyde. An endeavor to indicate mechanically the molecular action which occurs in the generation of frictional electricity. 2000 w. *Elektrotech Zeitschr*—April 28, 1898. No. 20454 B.

Ireland.

Electric Development in Ireland. Brief review of the progress being made in tramways and lighting, with particulars of some of the larger projects. 1700 w. *Prac Eng*—May 13, 1898. No. 20333 A.

Iron Loss.

The Conditions of Iron Losses in Electric Machines. (*Der Zusätzliche Eisenverlust in Elektrischen Maschinen*.) G. Dettmar. A description of tests on a rotary converter to determine the losses caused by the armature current. The results are discussed mathematically, and curves plotted. 4000 w. *Elektrotech Zeitschr*—April 21, 1898. No. 20450 B.

Magnetism.

Meteoric Magnetism. J. Warren. An explanation of the periodic fall of meteoric stones, and tending to show that the planetary universe is the center of an enormous magnetic field. 1800 w. *Elec*, Lond—May, 1898. No. 20226 A.

On the Susceptibility of Diamagnetic and Weakly Magnetic Substances. Albert P. Wills. Describes a method for the determination of the susceptibility of bodies in which it is extremely small, and giving the actual results obtained from experiments upon a number of substances. 3700 w. *Phys Rev*—April, 1898. No. 20307 D.

Magnets.

On the Properties of Seasoned Magnets Made of Self-Hardening Steel. B. O. Peirce. Records experiments made, and conclusions drawn, and states the disadvantages of self-hardening steel. 1800 w. *Am Jour of Sci*—May, 1898. No. 20034 D.

Permeability.

A Magnetic Balance for Workshop Tests of Permeability. J. A. Ewing. Read before the Inst. of Elec. Engs., London. Describes an instrument the use of which requires no knowledge of electrical testing, and which gives useful information in an easy way. 1800 w. *Elec*, N. Y.—May 25, 1898. No. 20398.

Purdue University.

Electrical Engineering at Purdue University. Illustrated description of the building and its equipment for the instruction of students, describing the electrical laboratory in detail. 2800 w. *Elec Wld*—May 28, 1898. No. 20381.

Radiography.

Adjustable X-Ray Tubes. A. A. C. Swinton. Read before the Rontgen Soc., London. Part first begins the study of the design of the Crookes tube, investigating the action of the focus tube, aiming at improvement in design. 2500 w. Elec Eng, N. Y.—May 12, 1898. Serial. 1st part. No. 20172.

A Résumé of the Experiments Dealing with the Properties of Becquerel Rays. Oscar M. Sewart. A summary of the present state of knowledge of the subject, with its bearing on the subject of X rays. 5000 w. Phys Rev—April, 1898. No. 20308 D.

On the Cathode-Ray Spectrum. M. Birkenland. From the *Comptes Rendus*. Describes results obtained in recent experiments. 1200 w. Elect'n, Lond—May 13, 1898. No. 20343 A.

Radiography and Radioscopy. (Radiographie et Radioscopie) E. Wallon. A review of the present status and most recent developments in connection with radiography and allied subjects. Serial. 1st part. 3000 w. Le Génie Civil—May 7, 1898. No. 20408 D.

What Are the X-rays? John Trowbridge. Believes the rays to be a manifestation of an electrical disturbance in space. Describes experiments and investigations, and shows the importance of the subject to physical science. Ill. 2300 w. Century Mag—May, 1898. No. 19945 D.

Report.

General Electric's Sixth Annual Report. Full report of the company, showing the earnings for the year to be less than those of last year. 6500 w. Elec, N. Y.—May 4, 1898. No. 20044.

Spain.

Electric Installations in Spain. (Elektrische Anlagen in Spanien.) A. Liëtke. A descriptive review of the existing electric plants in Spain, with especial reference to the market for German electrical apparatus. 2500 w. Elektrotech Zeitschr—May 5, 1898. No. 20455 B.

Thermo-Electricity.

The Thermo-Electric Electromotive Force of Crystallized Bismuth. (Sur les Forces Electromotrices Thermo-Electriques dans le Bismuth Cristallisé.) A paper by M. Louis Perrot, showing the influence of the relation of the direction of the current to the plane of cleavage, with valuable data in connection with the generation of thermo-electricity. 1800 w. Comptes Rendus—April 25, 1898. No. 20416 D.

Transformer Efficiency.

A Short Method of Determining Transformer Efficiency. S. E. Johannesen. Compares the shorter with the general method, illustrating its advantage. 250 w. Elec Wld—May 14, 1898. No. 20182.

MARINE ENGINEERING.**BOILERS AND ENGINES.****Dockyard.**

The Nagasaki Dockyard. Information concerning the dockyard and slips of the Mitsu Bishi Co., of Japan, and of Hitachi-Maru iron steamship now building. 1100 w. Engr, Lond—April 22, 1898. No. 20023 A.

Friction.

Horse-Power Absorbed by Skin Friction and Wave-Making in Ships of Different Forms and Proportions Deduced from Progressive Trials. James Hamilton. Read before the Inst. of Naval Archts, England. Statement of results deduced from trials of actual vessels showing the principles governing wave-making resistance. 2000 w. Engng—May 13, 1898. No. 20356 A.

Marine Lighting.

Naval Marine Electric Lighting. E. W. Countiss. Description of a war-ship electrical plant, method of installing, illustrations of fittings, fixtures, &c. 1500 w. Am Elect'n—May, 1898. No. 19971.

Marine Progress.

Industry as a Promoter of Marine Technology. (Die Industrie als Förderin der Marine technik.) An address by Herr Von Janke showing the relation between general industrial progress and the development of shipbuilding, with especial reference to the marine progress of Germany. 10000 w. Stahl und Eisen—May 1, 1898. No. 20443 D.

Net Register.

Minimum Net Register and Its Effect on Design. A. G. Ramage. Read at the meeting of the Inst. of Naval Arch'ts., England. The result to the general usefulness of the ship of aiming at a low net register. Abstract of discussion. 2500 w. Steamship—May, 1898. No. 20183 A.

Piping.

The Piping of a Modern Steamship. A. B. Willits. Description of the systems of piping necessary to the proper action of the machinery, with suggestions for arranging. 2200 w. Engr, N. Y.—May 2, 1898. No. 20059.

Resistance.

On Resistance to the Motion of Solids in a Fluid. B. Schieldrop. Read before the Inst. of Naval Arch'ts., England. The object of the paper is to point out a method by which it is hoped experimentally to secure information about the actual magnitude and character of the process to which the various parts of the skin of the solid are submitted. 6400 w. Engng—May 6, 1898. No. 20233 A.

Shipping.

A Simple Solution of the Shipping Question. Edward C. Plummer. An explanation of the system with statement of its advantages. 1100 w. N Am Rev—March, 1898. No. 19983 D.

Yacht.

Fastest Steam Yacht in the World. Illustrated description of the "Ellide," said to have attained a speed of forty miles per hour. 1500 w. Engr, N. Y.—May 2, 1898. No. 20058.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Explosions.

A Locomotive Boiler Explosion. Illustration and account of the wreck of locomotive No. 249, of the Chicago and Northwestern Ry., due to the explosion of its boiler, at Madison, Wis. 1000 w. Wis Engr—Jan., 1898. No. 20279 D.

Boiler Explosion at Paterson, N. J. Describes the destruction of a plant of 14 large boilers in the Passaic Rolling Mills. 600 w. Eng Rec—May 7, 1898. No. 20094.

The Boiler Explosion at Paterson, N. J. An illustrated article on this terrible explosion at the works of the Passaic Rolling Mill Company. 700 w. Eng Rec—May 14, 1898. No. 20216.

Boiler Setting.

The Hanging and Setting of the Horizontal Fire-Tube Boiler. Orosco C. Woolson. A criticism of the common method and the remedy. Ill. 4400 w. Am Soc of Mech Eng, No. 782—Jan., 1898. No. 20253 D.

Boiler-Waters.

The Engineering Chemistry of Boiler-Waters. Henry Lefman. A study of the corroding and scale-forming properties of water in determining its suitability for boiler use. Also discussion. 5200 w. Pro of Eng's Club of Phila—April, 1898. No. 20303 D.

Coal Combustion.

The Correct Method of Coal Combustion. W. H. Booth. Discusses the present practice in England, America and Germany, considering favorably the German system of mechanical stoking and presenting its advantages. 2000 w. Am Mach—May 26, 1898. No. 20502.

Evaporation.

Testing the Evaporation of Boilers. H. B. Budgett. From the *Journal of the British Society of Mining Students*. Deals with means of testing the duty a boiler is doing, giving three methods. 2300 w. Col Guard—May 13, 1898. No. 20359 A.

Feed Water.

The Economy from Heating Feed Water by Live Steam. Calls attention to a theory credited to Prof. Unwin relating to the value of feed heating. 5000 w. Eng Rec—April 30, 1898. No. 19953.

Gas Firing.

Producer Gas for Firing Boilers. Presents the advantages of this system of firing for the purpose of raising steam and its certainty of giving smokeless combustion. 2400 w. Prac Eng—May 6, 1898. No. 20243 A.

Heating Surface.

What Is the Heating Surface of a Steam Boiler? Charles Whiting Baker. Demonstrates that the surface exposed to the fire is the real heating surface of a boiler and reviews facts which show the relative heat absorbing power of water and gases. 4200 w. Am Soc of Mech Eng, No. 783—June, 1898. No. 20252 D.

Lagging.

Boiler and Steam Pipe Lagging. A. E. Urging the importance of lagging locomotives, and discussing the method. 1200 w. Am Eng & R R Jour—May, 1898. No. 19988 C.

Pipe Coverings.

The Protection of Steam Heated Surfaces. C. L. Norton. Partial Report of uncompleted investigations to determine the efficiency of several kinds of pipe covering, the fire risk of certain methods of insulation, and the gain in economy, &c. 4400 w. Am Soc of Mech Eng, No. 786—June, 1898. No. 20251 D.

Smoke Prevention.

Competitive Tests of Murphy Stoker and Hawley Down-Draft Furnace at Detroit Water-Works. Tests made to determine the relative efficiency of the two as regards smoke prevention and economy of fuel. 1300 w. Eng Rec—April 30, 1898. No. 19956.

Steam Engine Tests.

Extension of the Standard Uniform Methods of Conducting and Reporting Steam-Engine Tests. Bryan Donkin. Suggestions bearing on this subject. 2000 w. Am Soc of Mech Eng, No. 774—June, 1898. No. 20261 D.

Plea for a Standard Method of Conducting Engine Tests. George H. Barrus. Presents the need of devising a method for making engine tests in general, offering suggestions. 2000 w. Am Soc of Mech Eng, No. 773—June, 1898. No. 20262 D.

Steam Raising.

See Municipal Engineering, Gas Supply.

Superheating.

The Schmidt Superheating System. Translated from "Portefeuille Economique des Machines." Illustrated description. 1300 w. Am Eng & R R Jour—May, 1898. No. 19987 C.

Tubular Boiler.

The Horizontal Tubular Boiler. Some hints on the proper setting of this kind of boiler, with remarks on its construction and its durability and economy. Ill. 1500 w. Locomotive—April, 1898. No. 20218.

COMPRESSED AIR.

Haulage.

Compressed Air Haulage at Buck Mountain Colliery. T. D. Jones. Read at annual meeting of the Assn. Describes the plant and its operation, giving comparative costs. 1500 w. Anth Coal Op. Assn—May, 1898. No. 20041.

Liquefied Air.

Experiments with Liquefied Air. Brief description of the work accomplished by Charles E. Tripler, and of some experiments with the liquid. Ill. 2000 w. Compressed Air—April, 1898. No. 20033.

The Power Value of Liquid Air. Frank Richards. Discusses briefly what use to make of this peculiar product, showing that it is not

at present likely to be of much value for power or for refrigeration. 1000 w. *Am Mach*—May 28, 1898. No. 20500.

ENGINES AND MOTORS.

Balancing.

Balancing Steam Engines. Editorial on paper of James Whitchee, read before the Manchester Assn. of Engs. explaining principles of construction and means of avoiding vibration. 1000 w. *Engr*, Lond—April 26, 1898. No. 20124 A.

Bearings.

Journal Bearing Metals. Considers the best means of attaining a solid bearing to give the greatest satisfactory service at the least cost. 1100 w. *Ry Mas Mech*—May, 1898. No. 20108.

The Treatment and Prevention of Hot-Bearings. F. Bruton. A few suggestions and directions. 800 w. *Elec*, Lond—April 22, 1898. No. 19976 A.

Crank Angles.

The Effect of Different Arrangements of Crank Angles upon the Economy of Quadruple Expansion Engines. A. L. Mellanby. Read before the North-East Coast Assn. of Engs. and Shipbuilders, at Newcastle-on-Tyne. An account of a series of experiments carried out on the engines at the Durham College of Science. 2000 w. *Ind & Ir*—April 29, 1898. No. 20131 A.

Crank Shafts.

Computations for Multiple Crank Shafts for Marine Engines. (Berechnung Mehrmals Gekröpfter Kurbelwellen für Schiffsmaschinen.) H. Von Berling. A very comprehensive study of this important subject, with analytical and graphical investigation of stresses and strains, together with examples showing practical applications. 7500 w. *Zeitschr d Ver Deutscher Ing*—April 30, 1898. No. 25427 D.

Cylinders.

Cylinder Proportions for High-Pressure Steam. Editorial discussion of means of securing the greatest economy of the engine. 1000 w. *Loc Engng*—May, 1898. No. 19990 C.

Cylinder Ratios. James Andrews. Read before the North East Inst. of Engs. & Shipbuilders, in Sunderland. Aims at the systematic determination of the relative dimensions of the cylinders in multiple-expansion engines. Diagrams. 2300 w. *Ind & Ir*—April 22, 1898. Serial. 1st part. No. 20019 A.

Gas Engines.

On a Debated Point in the Theory of the Gas Engine. James D. Roots. Considers why the temperature actually produced only equals about 50% of what should be produced, calculated from the heat units supplied, suggesting a solution of this and other points. 2100 w. *Engr*, Lond—April 29, 1898. No. 20122 A.

The American-Kilmarnock Gas Engine. Illustrated detailed description. 1800 w. *R R Gaz*—May 20, 1898. No. 20297.

Governors.

The Shaft Governor. R. C. Carpenter.

Discusses the forms of shaft governors with an explanation of the theory. Ill. 3800 w. *Power*—May, 1898. No. 20053.

Lubrication.

Cylinder Lubrication. Considers the points governing the quantity of oil necessary for the perfect lubrication of steam cylinders, and how to get the best results. 3000 w. *Power*—May, 1898. Serial. 1st part. No. 20054.

Piston Rods.

Note on the Carbon-Contents of Piston-Rods as Affecting Their Endurance under Fatigue. Joseph E. Johnson, Jr. Data showing the superior endurance of high-carbon steel. 1300 w. *Am Soc of Mech Engs*, No. 776—June, 1898. No. 20259 D.

Pump.

A New Apparatus for the Elevation of Liquids. (Sur un Nouvel Appareil Destiné à l'Elevation des Liquides.) A new form of gyratory or helical pump, of small size and high efficiency. 1000 w. *Comptes Rendus*—April 12, 1898. No. 20412 D.

Pumping Engine.

See Mining and Metallurgy, Mining.

Water Motor.

A Simple Water Motor. E. J. Prindle. Illustrates and describes a wheel fitted to a fixed wash basin, by which a power amounting to about $\frac{1}{16}$ h. p. was obtained. 1000 w. *Ir Age*—May 12, 1898. No. 20179.

Water Wheels.

Impulse Water Wheels. J. T. Farmer. From a paper read before the Canadian Soc. of Civil Engs. A record of research concerning the desirable use of the impulse wheel, giving a brief outline of its development. 2200 w. *Can Eng*—May, 1898. Serial. 1st part. No. 20194.

The Evolution of the American Type of Water Wheel. W. W. Tyler. A review of the history of the American turbine, giving the results of the competitive tests at Philadelphia in 1859 and in 1876, with the improvements that have been developed and much interesting information. Ill. 6000 w. *Jour W Soc of Engs*—April, 1898. No. 20507 D.

POWER AND TRANSMISSION.

Cone Transmission.

Transmission by Cone Wheels for Automobiles. (Transmission par Cones pour Automobiles.) Max Ringelmann. A variable speed gear, using a friction plate between two pressure cones, especially adapted for speed controller on automobiles. 1000 w. *La Revue Technique*—April 25, 1898. No. 20401 D.

Electric Driving.

Electrically Driven Machinery. Schuyler S. Wheeler. Report of a lecture delivered at meeting of the New York Electrical Society, in Madison Sq. Garden. Presents the advantages of electric motors. 1300 w. *Elec*, N. Y.—May 18, 1898. No. 20286.

Hydraulic Power.

The Utilization of Water Power at Val de Travers. (Wasserkraftausnutzung in Val de

Travers.) Describing the manner in which over 5000 h. p. is taken from the Reuse by four successive power plants, before it flows into the Lake of Neuchatel. 1200 w. *Zeitschr d Ver Deutscher Ing*—April 23, 1898. No. 20425 D.

The Utilization of Water Power in the Alpine Countries for Railway Purposes. (Ueber die Ausnützung der Wasserkräfte in den Alpenländern zum Betriebe von Local- und Gebirgsbahnen.) An address by Adolf Prash giving a general account of the utilization of Alpine water powers, with data as to cost and performance. 7500 w. *Mitt d Ver f d Förd des Local- und Strassenbahnwesens*—April, 1898. No. 20466 F.

Motive Powers.

Motive Powers; Past, Present and Future. Discussion by the N. Y. R. R. Club, considering steam motors and cable motors. 8000 w. *N Y R R Club*—April 21, 1898. No. 20250 D.

Power Gas.

On Commercial Methods of Utilizing Blast-Furnace Gases for Power Production, and Other Possible Effects on the Pig-Iron Industry. B. H. Thwaite. Read before the conference of British Iron Trade Assn. Records the success of the Thwaite-Gardner blast-furnace power-system and its economic results, discussing the great thermal economies that may be effected. 3500 w. *Elec Eng, Lond*—May 13, 1898. Serial. 1st part. No. 20339 A.

On the Use of Blast-Furnace Gas for Motive Power. Adolphe Greiner. Read before the Iron and Steel Inst., England. A summary of investigations that have been made in this field, with the advantages accruing from the use of gas. 2500 w. *Ind & Ir*—May 13, 1898. No. 20347 A.

The Direct Application of Blast-Furnace Gases for Power Generation. (Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung.) An account of the practical success of the installation at the Cockerill Work at Seraing, and the report of Prof. Hubert thereon. 3000 w. *Stahl und Eisen*—April 15, 1898. No. 20441 D.

The Utilization of Blast-Furnace Gases. Abstract of paper by Dr. F. Luehrmann, read at meeting of German Iron Masters' Union. The paper stated all the objections to the use of gas engines in a blast-furnace plant, but the discussion regarded the subject more hopefully. 1200 w. *Eng & Min Jour*—April 30, 1898. No. 19963.

The Utilization of Blast-Furnace Gases for Electrical Power Transmission. W. H. Booth. Analyzes the amount of heat contained in waste gases and gives calculations for the horse-power of a blast furnace. 1300 w. *Elec Rev, Lond*—April 22, 1898. Serial. 1st part. No. 20005 A.

The Utilization of Blast-Furnace Gas for the Production of Power. W. H. Booth. A very complete discussion, showing the theoretical value of blast-furnace gases for use in gas engines, and also an account of the successful practical application and tests at Wishaw, near Glasgow. 3500 w. *Engineering Magazine*—June, 1898. No. 20476 B.

The Utilization of Blast-Furnace Gas in Gas

Engines at the Cockerill Company's Works. Translated abstract from an article by Prof. Hubert in the *Annales des Mines de Belgique*. Illustrates the arrangement in use, and explains the system briefly. 1000 w. *Ir & Coal Trds Rev*—April 29, 1898. No. 20127 A.

Power Plants.

The Comparative Advantages of Steam and Water Power. Discussion of the relative economy, and giving illustrations showing that every case must be determined on its merits, as these vary widely. 3000 w. *Can Elec News*—May, 1898. No. 20083.

Pulleys.

The Designing of Cone Pulleys. Walter K. Palmer. Discussion of the problem, with the deduction of a practical method. 8800 w. *Kansas Univ Quar*—April, 1898. No. 20223 D.

Steam Engines.

Armington and Sims New Slow Speed Engine. Illustrates general design and details of new form of inertia governor and releasing gear with steam dash-pot. 600 w. *Eng Rec*—April 30, 1898. No. 19958.

Steam Turbine.

The Steam Turbine Engine and Its Applications. Jno. D. Bailie. Abstract of a paper read before the Yorkshire College Engng. Soc. Describes the leading features of the "Twin Parallel Flow" and the "Radial Flow" turbines, the modern type, and the Steam Turbo-Dynamo. 3200 w. *Elec Rev, Lond*—May 6, 1898. No. 20245 A.

SHOP AND FOUNDRY.

Appliances.

Foundry Appliances. S. H. Stupakoff. Read before the Pittsburg Foundrymen's Assn. Discusses the equipment of the modern foundry, indicating directions where improvements may be made, possible economies, &c. 3700 w. *Ir Trd Rev*—May 26, 1898. No. 20515.

Bearings.

The Micro-Structure of Bearing Metal. Quotes conclusions of Dr. Dudley, chemist of the Pennsylvania R. R., and the results of personal study. 1000 w. *R R Gaz*—May 13, 1898. No. 20195.

Brass.

Brass-Melting Furnaces. Joseph Horner. Part first deals with the mixing metal, and methods of making brass. 2500 w. *Mech Wld*—April 22, 1898. Serial. 1st part. No. 19972 A.

Couplings.

The Relations between Forces and Stresses in Wedge Couplings. (Kraft- und Spannungsverhältnisse in Schubkeilkupplungen.) H. Bethmann. An analysis of that form of friction coupling in which a cut ring is expanded by a wedge. 1800 w. *Zeitschr d Ver Deutscher Ing*—May 7, 1898. No. 20429 D.

Crane.

100 Ton Derrick Crane. (Derrik-Kran von 100,000 kg. Tragfähigkeit.) Illustrated description of the powerful new wharf crane recently erected at the shipyards of Blohm & Voss, at

Hamburg. 1800 w. Zeitschr d Ver Deutscher Ing—April 16, 1898. No. 20421 D.

See Electrical Engineering, Power.

Cupola Cinder.

The Recovery of Iron from Cupola Cinder. W. J. Keep. Presented at convention of the Nat. Assn. of Stove Mfrs. at Phila. Gives facts concerning the prevention of this waste, and the saving effected. 1600 w. Met Work—May 28, 1898. No. 20525.

Deterioration.

Fatigue and Deterioration of Metals. Walter A. Zinn. An explanation of the cause, with discussion of whether steel or iron is better for railway car axles. 2400 w. Wis Engr—Jan., 1898. No. 20278 D.

Dies.

Relation of the Machinist's Trade to Die Making. George B. Painter. Presents some of the disadvantages due to the modern practice of dividing the work into sub-branches, and the limited knowledge of metal working. 1400 w. Am Mach—May 26, 1898. No. 20501.

Files.

Making Files. From *Modern Machinery*. Describes the making of files, and the difficulties met in endeavoring to have the work done mechanically, and the device which has proved successful. 2400 w. Bos Jour of Com—May 14, 1898. No. 20221.

Forgings.

Steel Forgings for Pumping Engines. H. F. J. Porter. Reviews briefly the history of the development of forging in the United States, and the processes which are considered the best practice for making steel forgings, the causes of defects, and the direction in which improvements are tending. Ill. 5000 w. Sib Jour of Engng—May, 1898. No. 20377 C.

Shop Costs.

Effective Systems of Finding and Keeping Shop Costs. Henry Roland. Describing the methods in use at the extensive machine tool works of Bement, Miles & Co., Philadelphia, with blank forms and details of daily application. 3000 w. Engineering Magazine—June, 1898. No. 20474 B.

Springs.

Steel Springs for Motor Cars. Excerpt of a paper read before the Liverpool Centre of the Self-propelled Traffic Assn., by J. Bedford. Gives an outline of the method of making bars suitable for making all kinds of springs, with analysis of acid steels used for laminated springs, with list of springs and their leading particulars. 1000 w. Prac Eng—May 6, 1898. No. 20242 A.

The Theory of Springs. (Theorie der Federn.) Prof. Kirsch. An elaborate mathematical treatment of plate, helical and spiral springs, with diagrams for aid in performing computations. 5000 w. Zeitschr d Ver Deutscher Ing—April 16, 1898. No. 20420 D.

What a Machine Designer Should Know About Springs. J. Begtrup. Presents the principles upon which their action depends in a

form that may be easily understood. Ill. 3500 w. Mach, N. Y—May, 1898. Serial. 1st part. No. 20049.

Stay-Bolts.

Bending Tests of Locomotive Stay-Bolts. Francis J. Cole. Illustrates the machine used for testing, discussing the results, giving photographs of test specimens and information concerning cost. 1500 w. Am Soc of Mech Engs, No. 775—June, 1898. No. 20260 D.

Tanks.

Making Tank Plates. Joseph Horner. Illustrated description of English practice. 1800 w. Am Mach—May 12, 1898. Serial. 1st part. No. 20165.

Tools.

Accurate Screw Machine Work Turning Tools. J. O. Surface. Hints on the making and use of tools. Ill. 1200 w. Am Mach—May 19, 1898. No. 20283.

Notes on the Driving of Machine Tools. (Zur Kenntniss der für Werkzeugmaschinen Gebräuchlichen Wendegetriebe.) H. Fischer. Especially devoted to improved driving and reversing gear for planers, with reference to increased cutting speeds. 6000 w. Zeitschr d Ver Deutscher Ing—May 7, 1898. No. 20428 D.

MISCELLANY.

Automobiles.

Automobile Vehicles. (Automobile.) L. Czischek. A general review of the subject, with many illustrations and tabulated details of performances. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—April 29, May 6, 1898. No. 20431 each B.

Recent Electric Motor Vehicles for City Streets. Illustrates and describes four types of horseless vehicles which are in daily use, and found to be successful and economical. 1500 w. Eng News—May 19, 1898. No. 20274.

The Freakley Steam Carriage. Illustrated description of an experimental carriage which has stood severe tests. Its great feature is its flexibility. 2400 w. Engr, Lond—April 22, 1898. No. 20026 A.

Cotton.

One Hundred Years of Ginning and Baling Cotton. George A. Lowry. History of the progress of mechanical invention in this field, giving much information. Ill. 3300 w. Am Soc of Mech Engs, No. 780—June, 1898. No. 20255 D.

Diagrams.

A New Graphical Method of Finding the Areas of Irregular Diagrams. Alfred E. Wiener. Gives a graphical method for measuring irregular planes. 1600 w. Am Mach—May 19, 1898. No. 20282.

Graphic Diagrams and Glyptic Models. R. H. Thurston. Discussing the value of graphic and glyptic methods, giving examples for illustration, showing how readily they permit the solution of important problems and other results of the applications of this system. Ill. 10000 w. Am Soc of Mech Engs, No. 777—June, 1898. No. 20258 D.

Elasticity.

The Equations of the Elastic Theory. (Sur les Equations de la Theorie de l'Elasticité.) A communication to the French Academy by MM. Eugène and François Cosserat, giving the fundamental equations of the mathematical theory of elasticity. 1500 w. Comptes Rendus—April 12, 1898. No. 20411 D.

Flow in Pipes.

Experiments on the Flow of Water in the Six-Foot Steel and Wood Pipe Line of the Pioneer Electric Power Company at Ogden, Utah. Charles D. Marx, Charles B. Wing and Leander M. Hoskins. Describes a series of experiments made to determine the relation between the rate of discharge and the loss of head between certain definite points, giving methods adopted and results obtained. Ill. 13800 w. Pro Am Soc of Civ Engs—May, 1898. No. 20394 F.

Hydraulic Pressures.

Experiments with Water under High Pressures. Their object was to determine the permeability of steel plates and the friction in steel pipes under heavy pressures. 600 w. Eng Rec—April 30, 1898. No. 19957.

Mechanical Plants.

See Architecture and Building, Construction.

Patents.

Patents. James W. See. Deals with questions on which inventive mechanics and manufacturers should be posted. 10300 w. Am Soc of Mech Engs, No. 779—June, 1898. No. 20256 D.

Pumps.

The Pump and Its Principle. Describes and illustrates the construction and mode of action of the common suction pump. 1800 w. Ill Car & Build—May 6, 1898. No. 20228 A.

Refrigeration.

Refrigerating Machinery. Howard Lee Davis. Describes the process of refrigeration, and plant, mentioning some of the peculiarities of ammonia. 2000 w. Yale Sci M—April, 1898. No. 20036 D.

Resistance.

A Study of Bach's Law $\epsilon = a\sigma^m$. (Studie über das Bachsche Gesetz $\epsilon = a\sigma^m$.) L. Geusen. A mathematical discussion of the law of Bach expressing the relation between extension and stress, with applications to practical examples. 3500 w. Zeitschr d Ver Deutscher Ing—April 23, 1898. No. 20424 D.

The Resistance of Thick Masses. (Sur la Résistance des Massifs Epais.) A note to the French Academy by M. Ribière, discussing the diminution of resistance to pressure in the interior of thick masses of material. 1200 w. Comptes Rendus—April 25, 1898. No. 20414 D.

Sand Blast.

See Mining and Metallurgy, Mining.

Skates.

The Manufacture of Skates. (Die Herstellung der Schlittschuhe.) An illustrated description of the methods of manufacturing skates of

various kinds, with details of processes and special machines. 2500 w. Stahl und Eisen—May 1, 1898. No. 20444 D.

Stage Mechanism.

Stage Mechanism. Edwin O. Sachs. Showing how modern sciences and methods have been applied in stage management. Ill. 5500 w. Jour Soc of Arts—April 22, 1898. No. 1975 A.

Stevens.

A Family of Engineers. T. C. Martin. An account of the great work of John Stevens and his sons. Ill. 4500 w. Cos—May, 1898. No. 20097.

Testing Materials.

Difficulties Encountered in Testing Cast Iron. P. Kreuzpointner. Read before the Pittsburg Foundrymen's Assn. Considers the question of solution and segregation affecting the physical qualities of cast iron, and difficulties because of the composition of its elements. 3200 w. Ir Trd Rev—April 28, 1898. No. 19951.

Experiments in Cast Iron Cylinders. C. H. Benjamin. Results of a series of experiments made to determine the bursting strength of cast iron cylinders under water pressure. Ill. 3300 w. Am Soc of Mech Engs, No. 778—June, 1898. No. 20257 D.

The Behavior of Wrought Iron Cylinders under Compression. W. Kendrick Hatt. Presents the results of a series of tests made at Purdue University, to determine the influence of the shape of the specimen on its ultimate strength, and other information. 1200 w. Eng News—May 12, 1898. No. 20159.

The Relative Strength of Wrought Iron and Steel Pipe. Report of tests made by Henry M. Howe, at the instance of the National Tube Works Co., the results showing a very great superiority of the steel pipe over the wrought iron. 1000 w. Am Mfr & Ir Wld—April 29, 1898. No. 19989.

Tubing.

Method of Manufacture and Tests of a New Seamless Tube. R. C. Carpenter and P. J. Fickinger. Describes a new form of tubing made by drawing lap welded steel tubing until the desired gauge is obtained. The process is fully described, and the high quality of the product shown by the results of tests. 2500 w. Am Soc of Mech Engrs, No. 785—June, 1898. No. 20469 D.

Water Conductors.

Experiences in Planning and Constructing Water Conductors. (Erfahrungen bei Projectierung und Betrieb von Wasserleitungen.) H. Adolf. Giving some points in connection with air trapping and water hammer; also influence of temperature changes. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—April 15, 1898. No. 20431 B.

Zeuner Diagram.

The Zeuner Diagram. William Fox. Aiming to prove that there are no problems incapable of an exact geometrical solution by means of this diagram. 800 w. Jour Fr Inst—May, 1898. Serial. 1st part. No. 19948 D.

MILITARY ENGINEERING.

Armaments.

The Growth of the World's Armaments. H. W. Wilson. An examination of the position of the great nations of Europe, based on statistics of the last thirty years. Diagrams. 1800 w. Nineteenth Cent—May, 1898. No. 20199 D.

Armor.

Armor Clads. Osborne Atwater Day. Historical account of the use of armor for the protection of vessels. 1300 w. Yale Sci M—April, 1898. No. 20037 C.

The United States Authorities and Krupp Process Armor. An important paper submitted to the U. S. Senate Committee on Naval Affairs by Capt. O'Neill, on the relative qualities and efficiency of European and American armor plate for warships, with English comment on the trial. 5000 w. Engr, Lond—April 22, 1898. No. 20024 A.

Armored Ships.

The First Battle Between Armored Ships. Accounts of the battle between the Merrimac and Monitor, and its effect on naval ship building. 5000 w. Loc Firemen's Mag—May, 1898. No. 19984.

Arsenal Equipment.

The Electrical Equipment of the Watervliet Arsenal. Brief account of the plant for supplying light and power for these mammoth gunshops of the United States. Ill. 1000 w. Elec Wld—May 7, 1898. No. 20062.

Auxiliary Vessels.

List of Vessels Recently Purchased or Requisitioned by the Navy. Reference table giving the new name of each vessel with her general characteristics. 1500 w. Marine Engng—May, 1898. No. 20114 C.

Battleships.

Launch of the United States Battleships Kearsarge and Kentucky. Illustrated description of these vessels with principal data of the launch. 3300 w. Marine Engng—May, 1898. No. 20112 C.

The Spanish Battleship "Pelayo." A brief description of the new boiler installation with leading particulars and dimensions. 1100 w. Engng—April 22, 1898. No. 20017 A.

The Trial of the Battleship. Park Benjamin, in the *Independent*. Comments on the complexity of the mechanical structure and increased liability to injury. 800 w. Am Mach—May 12, 1898. No. 20166.

Coal.

Coal in Modern War. From the *St. Louis Globe Democrat*. Some of the reasons why coal is a tremendous factor in modern naval operations. 1500 w. Bos Jour of Com—May 21, 1898. No. 20322.

Cruisers.

Spain's Armored Cruisers. Gives data with regard to these vessels and compares the American vessels. Ill. 1100 w. Engr, Lond—April 29, 1898. No. 20123 A.

The United States Protected Cruiser "Olympia." Brief review of this flagship of the Asiatic fleet, whose battle with a Spanish squadron in Manila Bay is now a topic of interest. Ill. 4500 w. Eng News—May 5, 1898. No. 20076.

Defense.

Maritime Construction and National Defense. (Les Constructions Maritimes et la Défense Nationale.) Calling attention to the weak points in the maritime defense of France and urging the encouragement of French establishments for the construction of marine work. 1200 w. Moniteur Industriel—April 30, 1898. No. 20462 G.

Explosives.

Modern High Explosives. A topical discussion in which their nature and mode of action was considered by Louis Y. Schermerhorn, and their application in warfare by Arthur Falkenau; a general discussion following. Ill. 6000 w. Pro of Engs' Club of Phila—April, 1898. No. 20302 D.

Guns.

Mechanical Operations in the Manufacture of a Great Naval Gun. Edwin J. Prindle. A richly illustrated article describing the work at the Washington Gun Factory, with especial reference to the construction of the 13-inch naval guns used on the U. S. battle ships. 4000 w. Engineering Magazine—June, 1898. No. 20472 B.

Holland Boat.

Electricity in the Submarine Boat "Holland." R. McA. Lloyd. A brief description of the electrical apparatus. Ill. 1000 w. Elec Eng, N. Y.—May 12, 1898. No. 20170.

"Maine."

The Destruction of the "Maine." Editorial on the report of the court of inquiry concerning this disaster, and advancing a possible hypothesis to account for the upward bend in the bottom as reported. 2300 w. Engng—April 22, 1898. No. 20015 A.

The "Maine" Disaster. Editorial holding the opinion that the explosion was outside the vessel on the port side. 800 w. Ind & Ir—April 22, 1898. No. 20020 A.

Manila.

The Great Naval Victory at Manila. Discussion of the opposing forces, giving the composition of both American and Spanish squadrons, and some information of the harbor fortifications. Map. 1800 w. Sci Am—May 14, 1898. No. 20164.

Position Finder.

An Apparatus for Pointing by Means of an Elevated Line of Metal Automatically Finding Concealed Position. Froissart. An illustrated outline of apparatus, stating the object sought and the results obtained. 7500 w. Jour U. S. Artillery—March-April, 1898. No. 20198 D.

Range-Finders.

Concerning the Reliability of Range-Finding

ts. Rohne. An investigation showing the certainty of correct fork construction, and the range can be made more reliable. 1000 w. Jour U. S. Artillery—March-April, 1898. No. 20197 D.

Rapid-Fire Guns.

The Rapid-Fire Guns of the New Orleans. Illustrated description of the guns and their operation. 1500 w. Sci Am—May 21, 1898. No. 20284.

Spanish Navy.

Strength of the Spanish Navy Brought Down to Date. Gives a series of reference tables, with remarks. 2000 w. Marine Engng—May, 1898. No. 20113 C.

Squadrons.

English Engineer's Analysis of Squadrons of Main and United States, with a Reply. Gives comparison published in the London *Engineer*, and a criticism of it. Ill. 2500 w. Sci Am—May 7, 1898. No. 20048.

Torpedo Boat.

An Electric Torpedo Boat. Advantages that

would result from the displacement of the steam engine by a primary battery for this kind of vessel. 1500 w. Elec Wld—May 21, 1898. No. 20269.

Compressed Air on the Holland Torpedo Boat. G. Wilfred Pearce. Reviews the previous attempts at submarine boat construction, describes the Holland boat, and the various applications of compressed air. Ill. 1800 w. Compressed Air—April, 1898. No. 20032.

Submarine Torpedo-Boats. William H. Jaques. Read before the Inst. of Naval Arch'ts. Refers to the defects in torpedo-boats made evident in the China-Japan war, and emphasizes the fact that submarine navigation is now an accomplished fact, discussing the influence it will have on torpedo-boat architecture and naval warfare. Ill. 4400 w. Engng—April 29, 1898. No. 20142 A.

War Material.

Illustrations of Machine Shop Work on War Material. Many illustrations with brief notes. Describes the Buffington-Crozier disappearing gun carriage, breech-loading rifled mortars, &c. 1800 w. Am Mach—May 5, 1898. No. 20203.

MINING AND METALLURGY.

COAL AND COKE.

Chemistry of Coal.

The Chemistry of the Coals of the Clyde Basin. W. Carrick Anderson. Summary of paper read before the Philosophical Society of Glasgow, written in competition for the Graham Gold Medal. Investigations with a view to finding out points of difference in character and action between non-coking and true coking varieties. 5500 w. Col Guard—April 22, 1898. No. 20021 A.

Coal Cutting.

Coal-Cutting Machinery. Cyrus Robinson. Considers its present efficiency and how it may be increased by a combination of electricity and compressed air. 1200 w. Mines & Min—May, 1898. No. 20067 C.

Coal Industry.

The Coal Industry of the Rhenish Westphalian Provinces. T. R. Mulvany. From the British Consular Repts. Shows the benefits from a combination of a number of collieries, thus doing way with reckless competition, and reports the conditions in detail. 3300 w. Ir & Coal Trds Rev—April 29, 1898. No. 20129 A.

Coke.

The Breaking and Classifying of Coke. M. Meyer. Translated from *Le Gaz*. Read before the Société Technique Belge de l'Industrie du Gaz, as a continuation of a similar paper read in 1896. Describes a new coke breaker, giving results obtained during a year's operation. 800 w. Ir & Coal Trds Rev—May 2, 1898. No. 20057.

Coking.

On Coking in By-Product Ovens. John H. Farby. Read before the Iron & Steel Inst., London. The manufacture of coke, with special attention to the recovery of by-products.

Many points of practice in the working of the Semet-Solvay oven are noticed. 2500 w. Ind & Ir—May 13, 1898. No. 20349 A.

Fuel Testing.

The Chemical Analysis and Testing of Fuel. L. Campredon. From *Annales de Chimie Analyt.* Explains the usefulness of analysis and testing in determining their suitability for the purposes intended, and defines chemical and ultimate analysis, describing special tests. 2500 w. Col Guard—April 29, 1898. No. 20135 A.

Germany.

By-Product Coke-Making in Germany. From a British Consular Report by T. R. Mulvany. Stating the advantages of coke-ovens with the recovery of by-products, the decrease in the number of round ovens and increase in by-product ovens, with particulars relating to the system used. 1200 w. Col Guard—April 29, 1898. No. 20136 A.

Coke Ovens and By-Products in Germany. Abstract from a Foreign Office Report by Kurt Seebohm. Reports the abandoning of the old round coke ovens and describes the systems adopted in the new by-product ovens. 1600 w. Ir & Coal Trds Rev—April 29, 1898. No. 20128 A.

Haulage.

See Mechanical Engineering, Compressed Air.

Indiana Coal.

Mining Indiana Coal. P. J. Mooney. Read before the Indiana Mining Inst. at Terre Haute, Indiana. Discusses the profitable amount to mine from the "L" seams, how to mine it and prevent creeps and squeezes. 1700 w. Mines & Min—May, 1898. No. 20065 C.

Peat.

The Application of North-German Peat n

Electric Power Stations. (Ueber die Verwertung der Norddeutschen Moore Insbesondere für Elektrische Kraftstationen.) A paper by Dr. Frank, showing the value of these deposits of turf, the heating value of which is about one-third that of an equal quantity of coal. 1500 w. Glückauf—April 16, 1898. No. 20447 B.

Production.

The Coal Production of the Principal Countries of the World. Interesting statistics taken from the annual statement by the Board of Trade. 2200 w. Col Guard—April 29, 1898. No. 20134 A.

COPPER.

California.

Copper Mining in California. H. A. Brainard describes the Copperopolis properties in Calaveras Co., and reports of deposits in other parts of the state are given. 1500 w. Min & Sci Pr—May 21, 1898. No. 20513.

Deposits.

The Copper Deposits Omaunu No. 2, Whangaroa County, N. Z. Report of an examination made by the government geologist. 1200 w. N Z Mines Rec—March 16, 1898. No. 20372 B.

GOLD AND SILVER.

Alaska.

Distribution of Gold in Alaska. R. H. Stretch. Presents views based on work extending over a period of three months. 1400 w. Min Ind & Rev—May 5, 1898. No. 20086.

The Alaskan Gold Fields and the Opportunities They Offer for Capital and Labor. Samuel C. Dunham. Report of official investigations made under government instructions, giving information of value on all subjects relating to this region. Ills. and maps. 7200 w. Bul of Dept of Labor—May, 1898. No. 20503 D.

Alluvial Mining.

Revival in Victorian Alluvial Mining. William Bradford. Information concerning the plains south of Ballarat. Ill. 1700 w. Aust Min Stand—April 7, 1898. Serial. 1st part. No. 20120 B.

Assay.

The Scorification Assay. John Daniell. Notes from the writer's experience in the estimation of gold and silver by this process. 1300 w. Jour of Chem & Met Soc of S Africa—March, 1898. No. 20078 E.

Colombia, S. A.

An Outline of the Gold Fields in Colombia, South America. Francis C. Nicholas. Statements based on extensive explorations of the country giving a general outline of certain conditions relating to the mines of this region. 2500 w. Eng & Min Jour—April 30, 1898. No. 19962.

Colorado.

Cyanid, Chlorination and Amalgamation in Colorado. R. B. Turner. Condensed from report of State Bureau of Mines. Information of the treatment of ores by these processes at

Cripple Creek and various other points, with the cost and manner of applying. 3000 w. Min & Sci Pr—May 21, 1898. No. 20514.

Concentration.

Concentration Plants for Small Mines. F. L. Bartlett. Presents the advantages of concentration and describes some simple and cheap plants, urging less costly and complicated mills. Ill. 3000 w. Eng & Min Jour—May 7, 1898. No. 20109.

Cyanid.

The Largest Cyanid Gold Reduction Works in the World. W. P. Hardesty. An interesting account of the Golden Gate Mill of the De La Mar's Mercur Mines Co., Mercur, Utah. Ill. 3500 w. Eng News—May 19, 1898. No. 20272.

Deep Leads.

The Deep Leads of Victoria. E. Lidgley. Giving account of the mining in Victoria, showing how the miner has been gradually sinking deeper shafts, and the great promise of the deep leads. 3500 w. Aust Min Stand—April 21, 1898. Serial. 1st part. No. 20380 B.

Dredging.

Dredging the N. S. W. Rivers. A. O. S. M. Suggests the advisability of testing the rivers known to contain auriferous gravel, and gives a brief history of this industry in New Zealand. Ill. 1300 w. Aus Min Stand—March 17, 1898. No. 20050 B.

Yukon Dredging. R. H. Stretch. Considers it exceedingly questionable whether such operations in Alaska would meet with success, and gives reasons for the opinion. 1200 w. Min Ind & Rev—May 19, 1898. No. 20360.

Gold Bearing Sands.

Notes on the Auriferous Iron-Sands of New Zealand. Alexander McKay. Describes these deposits, and the manner of working the beaches. 1200 w. N Z Mines Rec—April 16, 1898. No. 20373 B.

Klondike.

The Gold Region of the Klondike. Describes a new route to be opened by the Canadian government which will remove the great difficulties of transport to the Yukon district. Also briefly comments on the mistake of people going who were physically and intellectually unable to cope with the conditions existing. 900 w. Bd of Trd Jour—May, 1898. No. 20390 A.

Milling.

Milling and the Cyanid Process. Arthur Lakes. Kinds of ores to which the different processes are applicable are discussed. 1500 w. Mines & Min—May, 1898. No. 20069 C.

Mount Lyell.

Mount Lyell Up to Date. Describes the locality, conditions and surroundings of this mine in Tasmania. 3300 w. Aust Min Stand—March 17, 1898. No. 20051 B.

New South Wales.

The Minerals and Metals of New South Wales. Perry F. Nursey. Calling attention to points of interest in the report of T. A. Cogh

lan, government statistician. 1800 w. Ind & Ir—April 19, 1898. No. 20130 A.

New Zealand.

The Mining Industry of New Zealand. Perry F. Nursey. Gold mining is the predominating element. Information from the report of A. J. Cadman. 2400 w. Ind & Ir—April 22, 1898. No. 20018 A.

Ore Treatment.

Metallurgical Methods in Use at Broken Hill. G. H. Blakemore. History of the methods in vogue in this Australian mine, dealing with smelting, lixiviation and chloridizing, amalgamation and concentration. 2800 w. Aust Min Stand—March 31, 1898. Serial. 1st part. No. 20379 B.

Production.

United States Gold and Silver Production in 1897. Detailed statement comparing the figures with the two previous years. 2500 w. Eng & Min Jour—May 14, 1898. No. 20191.

Siberia.

The Siberian Railway and the Siberian Gold Districts. (Die Sibirische Eisenbahn und die Gold-vorkommen Sibiriens.) A discussion of the probable effects of the access by railway upon the gold regions of Siberia, with data as to locations and past output. 2000 w. Glückauf—April 30, 1898. No. 20448 B.

Tailings.

Successful Treatment of Tailings by the Direct-Filling Process. F. Cardell Pengilly. A short description of the plant and method of treatment by this process as carried on at the mines of the New Kleinfontein Co. (Limited), in the Witwatersrand goldfield, which has given good results. 1200 w. N Z Mines Rec—April 16, 1898. No. 20374 B.

Witwatersrand.

Milling the Gold Ores of the Witwatersrand. H. H. Webb, Pope Yeatman. A fully illustrated description of the mills of the various mining companies, showing the stamps, vanners, sorting belts, etc., with details of milling operations as conducted on the Rand. 4500 w. Engineering Magazine—June, 1898. No. 20475 B.

IRON AND STEEL.

Bilbao.

Past and Present at Bilbao. (Altes und Neues über Bilbao.) A. Kaysser. A descriptive sketch of former and modern methods of handling iron ore at the Spanish port. 3000 w. Stahl und Eisen—April 15, 1898. No. 20442 D.

Blast Furnaces.

On the Relative Merits of Limestone and Lime in Blast-Furnace Practice. Charles Cochran. Read before the Iron and Steel Inst., England. Presents the results of a comparison of limestone and lime employed as flux at a furnace 90 feet high and about 34,500 cubic feet capacity, at Ormesby Ironworks, Middlesbrough. 3000 w. Ind & Ir—May 13, 1898. Serial. 1st part. No. 20348 A.

Carbon.

The Moist Combustion Methods of Deter-

mining Carbon in Steel. George Auchy. Presented to the Am. Chem. Soc. Showing that this process may work faultily in particulars mentioned. 1500 w. Ind & Ir—April 29, 1898. Serial. 1st part. No. 20132 A.

Furnaces.

Re-Heating Furnaces for Iron and Steel. Fred. Mills. Considers some of the re-heating furnaces in the districts of the West of Scotland and the Northeast Coast. Ill. 2200 w. Ir & Coal Trds Rev—April 22, 1898. No. 20004 A.

India.

The Iron Resources of India. Editorial on the report of Jeremiah Head, quoting some facts. 2500 w. Engng—May 6, 1898. No. 20231 A.

Metal Working.

Effects of Heating and Working on Iron and Steel. H. E. Smith. Treats of the effects of working and heat treatment which result in bringing out the highest qualities of the iron or steel, or which unfit the metal for the use intended. 3700 w. Jour Assn of Engng Soc's—March, 1898. No. 19979 C.

Pig Iron.

How to Secure Uniformity in Pig Iron Analysis. Extracts from letters drawn out by paper of Thomas D. West before the Pittsburg Foundrymen's Assn. 2800 w. Ir Trd Rev—May 5, 1898. No. 20118.

How to Secure Uniformity in Pig Iron Analysis. Further extracts from letters called out by paper of Thomas D. West before the Pittsburg Foundrymen's Assn. 1800 w. Ir Trd Rev—May 12, 1898. No. 20184.

Silicon.

The Conditions in Which Silicon and Chromium are found in Siderurgical Products. (Recherches sur l'Etat où se Trouvent le Silicium et le Chrome dans les Produits Sidérurgiques.) MM. Carnot and Goutal. An examination of the manner in which silicon and chromium are combined with iron and carbon as a result of smelting operations. 2500 w. Comptes Rendus—May 2, 1898. No. 20418 D.

Statistics.

Some Graphic Statistics. George R. Bale. Diagrams showing production of iron and steel of various countries in 25 years, with the present position, are given in part first. 700 w. Prac Eng—April 29, 1898. Serial. 1st part. No. 20125 A.

Structure.

The Crystalline Structure of Iron and Steel. John E. Stead. A résumé of the more practical points of a paper presented at the meeting of the Iron and Steel Inst., London. 3000 w. Ir & St Trds Jour—May 14, 1898. No. 20332 A.

Tin-Plate.

The Position and Prospects of the Tin-Plate Industry. John Jenkins. A paper read at meeting of the British Iron Trade Assn. Gives figures showing total production, exports, etc., comparing them with the United States reports, with discussion of cost, and points relating to transportation, etc. Also discussion. 2000 w. Col Guard—May 6, 1898. No. 20237 A.

MINING.

Coal Dust.

The Coal Dust Danger, and Methods of Combating it. (Die Kohlenstaubgefahr und ihre Bekämpfung.) An address by Director Behrens upon the dangers of coal dust explosions in mines, with especial reference to the method of preventing them by sprinklers. Two articles. 6000 w. Glückauf—April 16, 30, 1898. No. 20446 each B.

Electric Mining.

Central-Station Electric Coal-Mining Plant in Pennsylvania, U. S. A. William Stukely Gresley. Paper giving an illustrated description of the plant and its operation, with an abstract of the discussion. 16500 w. Pamphlet. Published by Inst. of Civil Engs., London. No. 20399 G.

Electrical Appliances in Colorado Mines. Thomas Tonge in London *Mining Journal*. Calls attention to the readily available power to be found in the mountain streams, and mentions a few of the leading instances where this power has been utilized for electrical purposes. 1200 w. N Z Mines Rec—April 16, 1898. No. 20375 B.

The Applications of Electricity in Mining Operations. Roslyn Holiday. From the *Journal of the British Society of Mining Students*. Deals with application of electricity to lighting, hauling, pumping and coal-cutting. 3500 w. Col Guard—May 6, 1898. No. 20239 A.

Fan Curves.

Fan Characteristic Curves. S. Hanappe, in a paper to the Société des Ingénieurs des Mines du Hainaut. An examination of some of these curves as bearing upon a full sized Guibal fan. 4000 w. Col Guard—May 6, 1898. No. 20236 A.

Firedamp.

Carbonic Oxid, Firedamp, and the Grisou-metre. (L'Oxyde de Carbone, Le Grisou, et le Grisoumètre.) An address delivered by Dr. Gréhan, describing the application of his device called the grisoumètre for determining the proportion of dangerous gases in mine air. 6000 w. Bulletin de la Société d'Encour—April, 1898. No. 20409 G.

Explosives and Firedamp in Belgium. (Les Explosifs et le Grisou en Belgique.) H. Schmerber. A critical review of the investigations made in Belgium as to the effect of various blasting explosives in igniting firedamp. 1500 w. Le Génie Civil—April 23, 1898. No. 20404 D.

Explosives and Firedamp. (Explosifs et le Grisou.) H. Schmerber. A review of the present condition of the subject in the principal mining countries of Europe. 3500 w. Le Génie Civil—April 30, 1898. No. 20406 D.

The Ignition of Firedamp by Electricity. (Entzündbarkeit der Schlagwetter durch Elektrizität.) A review of the experiments of Drs. Heise and Thiem, with a reply by Dr. Heise. 3000 w. Glückauf—May 7, 1898. No. 20449 B.

The Influence of Self-Induction in the Explosion of Mixtures of Fire-damp and Air by the

Electric Spark. (Sur l'Influence de la Self-Induction dans l'Explosion des Mélanges de Grisou et d'Air par l'Étincelle Électrique.) A note to the French Academy by MM. Couriot and Meunier, discussing the conditions under which self-induction may become a source of danger. 1500 w. Comptes Rendus—April 18 1898. No. 20413 D.

Mining Motors.

The Design of Mining Motors. F. C. Caldwell. Read before the Ohio Inst. of Min Engs. The principles of their construction and the points to be considered in selecting motors for mining work. Ill. 2200 w. Mines & Min—May, 1898. No. 20066 C.

Pneumatophore.

Employment of the Pneumatophore in Irrespirable Gases. Bergrat Behrens. From a communication to Glückauf. Reports experiments made at the Shamrock Colliery in Westphalia, to determine the extent to which the apparatus could be used in an underground fire. The trials show that a certain amount of instruction and practice is required for its use. 2000 w. Col Guard—April 29, 1898. No. 20137 A.

Pumping Engine.

A Triple-Expansion Mine Pumping Engine. Illustrated description of a mine pumping engine for the New Jersey Zinc Co., showing some novel features. 600 w. Eng News—May 5, 1898. No. 20072.

Safety Appliances.

Safety Appliances in Winding Shafts. Victor Watteyne and Armond Halleux. From a report on the plant and methods of mine working at the Brussels International Exhibition of 1897. Illustrated description of apparatus for the protection of shafts at landings, for preventing the cage being drawn up to the pulleys, or attaining excessive speed, &c. 4000 w. Col Guard—May 13, 1898. No. 20358 A.

Safety Lamps.

Some Notes on the Safety Lamp Problem. H. W. Halbaum. The object of the paper is to show that in some respects the incandescent lamp is inferior to the best form of Davy, as it introduces new sources of danger. 3300 w. Col Guard—April 29, 1898. Serial. 1st part. No. 20133 A.

Sand Blast.

Sand Blast Apparatus for Mining Purposes. Describes the construction and operation of the apparatus. 900 w. Eng & Min Jour—May 14, 1898. No. 20192.

Shot-Firing.

Electric Shot-Firing in Mines. Presents the advantages of the electric method over the fuse method, and gives essential particulars that should be carried out to obtain the best results. 1800 w. Elec Eng, Lond—May 13, 1898. No. 20337 A.

Unloading.

Coal Unloading Machines. W. B. Hanlon. An illustrated description of different types of car-dumping machines used at Lake Erie ports,

with an account of some earlier devices and the improvements to the present time. 4000 w. Mines & Min—May, 1898. No. 20063 c.

MISCELLANY.

Electric Furnaces.

See Electrical Engineering, Miscellany.

Iowa.

Iowa Mineral Production in 1897. H. Foster Bain. Summary of statistics of production of the various minerals mined in the State. 1100 w. Eng & Min Jour—May 7, 1898. No. 20110.

Lead Refining.

The Electrolytic Refining of Lead. Sherard Cowper-Coles. Describes the processes. 1000 w. Elec Rev, Lond—April 22, 1898. No. 20010 A.

Manganese.

The Manganese Ore Industry of the Trans-Caucasus. From a consular report by Consul Stevens of Batoum. Reports the industry in a deplorable condition. 900 w. Col Guard—May 6, 1898. No. 20240 A.

Metals.

The Metals Used by the Great Nations of Antiquity. J. H. Gladstone. Discourse delivered at the Royal Inst. Considers recent

knowledge acquired concerning the metals used by different nations at different epochs of their history. 5800 w. Nature—April 21, 1898. No. 19995 A.

Mineralogical Museum.

The Mineralogical Museum of the Colorado State Mining Bureau in the Capitol Building, at Denver, Colorado. Presents its uses and advantages to miners and students, with illustrated description of interesting and peculiar minerals and specimens there shown. 4000 w. Mines & Min—May, 1898. No. 20068 c.

Mortality.

Mining Mortality in England and Wales. James Barrowman. Compares the last two decennial reports to see whether improvements in conditions affect the vital statistics; also makes comparison with other occupations. 1300 w. Col Guard—April 22, 1898. No. 20022 A.

Petroleum.

Petroleum Fields of California. Statistics of production in Southern California, during 1897. 1100 w. Am Mfr & Ir Wld—May 13, 1898. No. 20222.

South Wales.

Reports of the Inspectors of Mines for 1897. Shows the number of persons employed, output of minerals, accidents, &c. 1000 w. Col Guard—May 6, 1898. No. 20238 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene and its Importance as an Illuminating Material. (Das Acetylen und seine Bedeutung als Beleuchtungsmittel.) Dr. Karl Thomae. A discussion of the chemistry of acetylene and a description of its progress, especially on the Continent. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—April 30, May 7, 1898. No. 20426 each D.

Destruction of the Liquefied Acetylene Works at Jersey City. Official information, with report of the inquest and editorial comment. Ill. 9500 w. Pro Age—May 2, 1898. No. 20056.

Carbid.

The Cost of the Production of Calcium Carbid. (Kosten der Calciumcarbid-Darstellung.) A computation, based upon the thermochemical and dynamical equivalents, and including costs of plants of various sizes and kinds. 2000 w. Der Electro-Techniker—April 30, 1898. No. 20465 B.

The Quality of Calcium Carbid. Gives details of one or two of the most approved methods of analysis of calcium carbid. 1800 w. Jour Gas Lgt—May 17, 1898. No. 20384 A.

Charging.

Charging Apparatus for Small Works. R. Watson. Illustrates and describes a simple, efficient and cheap scoop-charging apparatus. 2000 w. Gas Engs Mag—May 10, 1898. No. 20327 A.

Cyanids.

The Production and Consumption of Cyanids. Part first presents the necessity of the gas manager keeping informed on the progress of processes for gold recovery in order to anticipate the demand for cyanids; and also to keep informed regarding its production from other sources. 2000 w. Jour Gas Lgt—May 10, 1898. Serial. 1st part. No. 20293 A.

Gaseous Pressures.

The Measurement of Small Gaseous Pressures. Charles F. Brush. Read before the Am. Assn. for the Advancement of Science. Discusses a modified form of McLeod gauge used by the author in investigations requiring measurement of slight pressures. Ill. 1800 w. Science—May 27, 1898. No. 20526.

Gas Stoves.

The Comparative Cost of Cooking by Gas and Coal. Thomas Fletcher. An attempt to fix the standards by which the relative costs can be compared, giving conclusions favoring the use of gas. 2000 w. Gas Wld—May 7, 1898. No. 20247 A.

The Gas-Stove Cooking Demonstration from a Gas Manager's Point of View. Norton H. Humphreys. Discusses the business methods for advertising gas cookers; the exhibitions, lectures, letting stoves on hire, and other expedients. 2800 w. Gas Wld—May 7, 1898. No. 20248 A.

Governor.

Automatic Gas Governor. An illustrated description of a system of automatically regulating

pressures and similar work, introduced by Frederic Maquaire. 900 w. Engng—April 29, 1898. No. 20139 A.

Municipal Ownership.

The Municipality and the Gas Supply, as Illustrated by the Experience of Philadelphia. L. S. Rowe. Presents a careful examination of the history of these works, the causes of the defects connected with the city management, the conditions under which the lease was effected with a discussion of questions of public policy, concluding that the step taken marks a retrograde movement. 6700 w. An of Am Acad—May, 1898. No. 20305 H.

Retorts.

Retort Heating. G. P. Lewis. The first of a series of articles discussing the principles and relative advantages of the several systems of heating retorts with gaseous fuel, and giving formulæ that will assist in lessening the work of calculation. 900 w. Gas Wld—May 14, 1898. Serial. 1st part. No. 20340 A.

Standard.

A New Standard of Luminosity. (Sur un Nouvel Etalon Lumineux.) Ch. Féry. Describing a method of obtaining a flame of acetylene of constant and uniform brilliancy, suitable for use as a standard of comparison for photometric measurements. 1200 w. Comptes Rendus—April 25, 1898. No. 20415 D.

Steam Raising.

Economical Methods of Raising Steam in Gas Works. C. Drury. Read at meeting of the North of England Gas Managers' Assn. Shows the need of steam in gas works and discusses the methods whose cheapness recommends them, giving especial attention to heating the boiler by means of waste gases from the retort settings. Discussion. 3800 w. Jour Gas Lgt—May 3, 1898. No. 20190 A.

Street Lighting.

Street Lighting by Incandescent Gas-Burners. Remarks, report and discussion at the meeting of the Eastern Counties Gas Managers' Assn. at Peterborough, Eng. 7200 w. Jour Gas Lgt—April 26, 1898. No. 20070 A.

Water Gas.

The Adoption of Carburetted Water Gas. D. Terrace. Read at meeting of the North of England Gas Managers' Assn. States a few of the advantages that led to the introduction into the various gas-works, with a short description of the working of the apparatus. Also discussion. Ill. 7500 w. Jour Gas Lgt—May 3, 1898. No. 20189 A.

Water Gas and Its Applications. Vivian B. Lewes. Briefly reviews the progress of water gas, the economic conditions which up to the present have prevented pure water gas from coming into general use, the success of carburetted water gas, and the history of the industry, noting also recent developments in manufacture which will probably influence its future. Discussion. 8000 w. Jour Soc of Arts—May 13, 1898. No. 20330 A.

Welsbach.

Kern's Incandescent Gas-Burner. A full ab-

stract of the specification of the first patent, with illustrations accompanying it. 3000 w. Jour Gas Lgt—May 10, 1898. No. 20294 A.

The New Burner of the Welsbach Company. Favorable discussion of the new invention of M. Kern. 2000 w. Jour of Gas Lgt—May 10, 1898. No. 20292 A.

The New Welsbach Burner. Describes an invention of Ottmar Kern which nearly doubles the efficiency of the burner. 2200 w. Gas Wld—May 7, 1898. No. 20249 A.

SEWERAGE.

Filtration.

More About Filtration of Sewage Through Coal. Information from a paper by A. Bostock Hill, given in response to an inquiry. Gives details of the construction of the filter tried at Wolverhampton, Eng. 1400 w. Munic Engng—May, 1898. No. 20028 C.

Flushing.

Flushing Pipe Sewers. H. N. Ogden, Jr. Abstract of a paper read at meeting of Am Soc. of Civ. Engs. Reports experiments made on sewers of Ithaca, N. Y., and conclusions drawn from available information, with summary of discussion. 1600 w. Eng News—May 12, 1898. No. 20161.

Iron Pipe.

Iron Pipe for Sewers. Charles Carroll Brown. A criticism on the action taken in an Illinois city, with some of the objections to iron pipe. 800 w. Munic Engng—May, 1898. No. 20029 C.

Sewage.

Purification of Sewage in England. John W. Alvord. Read before the Illinois Soc. of Engs. and Surveyors. Describes a chemical system in use in the borough of Acton, a suburb of London, its operation and efficiency. 2000 w. Munic Engng—May, 1898. No. 20031 C.

Sewage Disposal.

What Electrolyzed Sea Water Has Accomplished. W. L. Hedenberg. Explains the methods invented by Albert E. Woolf and M. Hermite, giving reports of applications of the process and the results. 1500 w. Elec, N. Y.—May 18, 1898. No. 20287.

Sewerage Problems.

Rainfall and Run-Off in Relation to Sewerage Problems. Walter C. Parmley. A comprehensive study of this subject, presenting the difficulties and the remedies. 7200 w. Jour Assn of Engng Soc's—March, 1898. No. 19978 C.

STREETS AND PAVEMENTS.

Brick.

Brick Paving. Irving E. Howe. Gives a brief description of the construction, and a statement of cost of the brick paving on Seventh street in the city of Minneapolis, laid during the season of 1897. 1300 w. Jour Assn of Engng Soc's—March, 1898. No. 19980 C.

Street Cleaning.

Observations on Street-Cleaning Methods in European Cities. George E. Waring, Jr. Re-

port of observations made in the summer of 1896, based on an examination of the street-cleaning methods of Vienna, Budapest, Munich, Berlin, Cologne, Brussels, London, Birmingham, Paris, Turin and Genoa. 25500 w. *Munic Affairs Sup*—June, 1898. No. 20368 D.

Review of the General Work of the Department of Street Cleaning of New York. Reports of the mechanical department; final disposition, waste disposal, and the principal factors which make up the cost. Ill. 35000 w. *Munic Af Sup*—June, 1898. No. 20369 D.

The Labor Question in the Department of Street Cleaning. Deals with the adjustment of labor questions by the "Committee of 41" and the Board of Conference in New York. 3500 w. *Munic Af Sup*—June, 1898. No. 20371 D.

The Problem of Snow Removal in New York. Gives historical sketch relating to this work from 1881 to 1895 comparing with results since that date. 12500 w. *Munic Af Sup*—June, 1898. No. 20370 D.

WATER SUPPLY.

Bandora, Bombay.

The Sanitation of Bandora. John Wallace. A report and project of water supply, drainage and conservancy for this municipality. 7500 w. *Ind & East Eng*—April, 1898. No. 20289 D.

Chicago Works.

The Chicago Water-Works Extension Tunnels. Illustrated description of the design and methods of construction of the North East Lake tunnel. 6400 w. *Eng Rec*—May 21, 1898. Serial. 1st part. No. 20314.

Duluth, Minn.

The Municipal Water-Works of the city of Duluth, Minn. W. B. Patton. Describes the situation, geology and topography of the city, giving the history of the water supply, and the plans for an independent system covering the whole city. Ill. 5500 w. *Eng News*—May 5, 1898. No. 20071.

Frankfort, Germany.

The New Water-Works of Frankfort, Germany. James H. Fuertes. Illustrated description of a novel driven-well plant. 900 w. *Eng Rec*—May 21, 1898. No. 20315.

Hamilton, Ohio.

Hamilton and Its Water Works. Illustrated description of an artesian-well supply system. 1200 w. *Fire & Water*—April 30, 1898. No. 19993.

Hampton Court.

How Wolsey Obtained the Water Supply for Hampton Court. From the *Surrey Comet*. Brief historical account of the early water supply of this palace, with remarks on the value of the pipe and excellence of the work. 600 w. *San Rec*—May 13, 1898. No. 20328 A.

Intake.

The Construction of the New Cleveland Water-Works Intake. Illustrated description of the building of this 9-foot, brick-lined tunnel, 26000-feet long, which presented many difficulties overcome by novel methods of working. 5000 w. *Eng Rec*—May 7, 1898. No. 20090.

London Supply.

The Staines Reservoirs. Perry F. Nursey. Brief history of project, and the difficulties met, by which London is to be provided with an adequate water supply. The first sod was turned April 30, which inaugurated the important undertaking. 2700 w. *Ind & Ir*—May 6, 1898. No. 20241 A.

The Staines Reservoirs Scheme. A description of the works, with map. 800 w. *Jour Gas Lgt.* May 10, 1898. No. 20295 A.

Madison, Wis.

Report of the Water Board of Madison. Account of recent improvements and related matters. Ill. 1600 w. *Fire & Water*—May 7, 1898. No. 20121.

Meters.

Meterage at Madison, Wis. Explains the thorough success of the system and the results. 1400 w. *Fire & Water*—May 14, 1898. No. 20224.

Meter Testing.

Meter Testing in Baltimore, Md. Illustrates apparatus used. 500 w. *Eng Rec*—May 14, 1898. No. 20213.

Potable Water.

Potable Water: Its Supply and Distribution. W. J. Eden Crane. Reviews the various appliances and conductors for furnishing the people with drinking water and water for other purposes, since the earliest times. Ill. 3800 w. *Ill Car & Build*—April 22, 1898. No. 19973 A.

Pumping-Plant.

A Deep-Well Pumping Plant at Waukesha, Wis. J. W. Ledoux. Describes and illustrates the plant and reports tests made. Discussion. Ill. 4800 w. *Pro of Eng's Club of Phila*—April, 1898. No. 20304 D.

Regulations.

Oswego Water Regulations. A copy of the code of regulations issued for the guide of master plumbers. 1000 w. *San Plumb*—May 1, 1898. No. 20101.

Reservoir Losses.

The Loss of Water from Reservoirs by Seepage and Evaporation. L. G. Carpenter. Gives the results of a series of observations to determine the loss from seepage, on reservoirs near Fort Collins, Colo., with observations on evaporation. 9500 w. *State Agricul Col, Ft. Collins, Colo*—Bulletin 45—May, 1898. No. 20309 D.

Rockford, Ill.

Increasing the Water Supply of Rockford. Gives the general plan of the work, with suggestions for the avoidance of waste. Ill. 1200 w. *Fire & Water*—April 30, 1898. No. 19994.

Subaqueous Pipes.

Subaqueous Pipe Laying, Boston, Mass. Illustrated description of construction of several 36-inch submerged mains of the Metropolitan water-works. 1000 w. *Eng Rec*—May 14, 1898. No. 20214.

Wasted Water.

The Right to Shut Off Water. Abstract of

ruling of Court of Appeals in an action to restrain the water commission of Albany, N. Y., from cutting off supply of a consumer refusing to pay charges for wasted water. 1100 w. Eng Rec—May 7, 1898. No. 20087.

The Use of Water in Madison, Wis. A review of the probable use and waste of water in small cities. 1100 w. Eng Rec—May 7, 1898. No. 20088.

Water Mains.

Assessments for Water Mains. Review of a decision of the U. S. Supreme Court establishing the legality of a tax per front foot without regard to the cost of the main. 1000 w. Eng Rec—May 21, 1898. No. 20311.

Wells.

Artesian Bored Tube Wells. Maurice Ockenden. Read before the Civil and Mech. Eng's. Soc. of London. Reviews the means adopted for boring or drilling wells, giving ancient methods and the more important ones in present use. 2000 w. Col Guard—April 29, 1898. No. 20138 A.

MISCELLANY.

Annexations.

Suburban Annexations. A. F. Weber. Presents statistics showing that the movement is the recognition of new economic conditions. 1500 w. N Am Rev—May, 1898. No. 19982 D.

City Charter.

The Proposed New Charter for the City of San Francisco. Some features of this charter are presented with editorial comment. 4000 w. Eng News—May 26, 1898. No. 20518.

Destructor.

Experiments with Rubbish Destructors in Berlin (Die Versuche mit der Müllverbrennung in Berlin.) A general report of the official tests of the destructors at Berlin, with data as to capacity, operation and working expenses. 2 articles. 5000 w. Gesundheits Ingenieur—April 15, 30, 1898. No. 20440 each B.

Garbage Destructors. A. E. Brooke Ridley. Briefly reviews the three principal systems of

destructor plants as used at Shoreditch, Ealing, and Oldham. Ill. Elec. N. Y.—May 11, 1898. No. 20185.

Explosion.

Gas Explosion in the Cleveland Water-Works Tunnel. Describes an explosion of natural gas which killed or injured eight men. Caused by electricity. 700 w. Eng Rec—May 21, 1898. No. 20313.

Garbage.

Garbage Disposal. Thomas B. Carpenter. Reviews methods old and new, but concludes that no perfectly satisfactory method for all times and all places has yet been devised. 3300 w. San—May, 1898. No. 20042 D.

The Disposal of Waste Liquids from Garbage Reduction. Describes a method of evaporating these liquids which prevents odors and yields a revenue. 700 w. Eng Rec—May 7, 1898. No. 20089.

Municipal Rights.

The Right to Lease Public Works. A decision of the Utah Supreme Court forbidding the lease of the Ogden water-works to private parties. 1000 w. Eng Rec—May 14, 1898. No. 20209.

Quasi-Public Works.

A New Plan for the Control of Quasi-Public Works. J. D. Forrest. Presents a plan recently brought forward by Alfred F. Potts, which is, in brief, the management by disinterested trustees of institutions endowed for the purpose of rendering the public service at cost. 4500 w. Am Jour of Soc—May, 1898. No. 20202 D.

Wastes.

The Removal and Utilization of Animal Wastes and Bodies. (Die Beseitigung und Verwertung von Fleischabfällen und Tierischen Kadavern.) Dr. Haefcke. Description of the Otto apparatus for recovering all valuable matter from animal wastes, avoiding injury to public health. 1500 w. Zeitschr d Ver Deutscher Ing—April 16, 1898. No. 20423 D.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in April, 1898. Detailed list and classified summary. 2800 w. R R Gaz—May 27, 1898. No. 20523.

India.

Recent Railway Policy in India. Horace Bell. A comprehensive view of the general railway policy, with criticisms and historical account of these railways, with important discussion. 16000 w. Jour Soc of Arts—April 29, 1898. No. 20143 A.

Mails.

The Cost of Carrying the United States Mails. Interesting statistics on the cost of transporting mails by railroad, aiming to show that the pres-

ent compensation should not be reduced. 1800 w. R R Gaz—May 6, 1898. No. 20105.

M. C. B. Rules.

The M. C. B. Rules of Interchange. The proposed changes, and the discussion by the Jersey City lodge of the Car Inspectors' and Repair Men's Assn. 2800 w. R R Car Jour—May, 1898. No. 20116.

Railway Progress.

Presidential Address to the Institution of Mechanical Engineers. Samuel Waite Johnson. A review of British railway progress, with special reference to the Midland Railway. 3400 w. Engng—May 13, 1898. Serial. 1st part. No. 20357 A.

Resistance.

Atmospheric Resistance to the Motion of

Railroad Trains. W. F. M. Goss. From a paper read at the April meeting of the Western Ry. Club. Also editorial. Describes experiments made, and gives conclusions reached. 7000 w. R R Gaz—May 20, 1898. No. 20300.

FINANCIAL.

American Railways.

An English View of Our Railways. W. M. Acworth, in the London *Times*. Considering the financial aspects of American roads. 3200 w. Ry Age—April 20, 1898. No. 19991.

Canada.

The Development of the Railways of Canada. Walter E. Weyl. A critical discussion of the development, operation and present condition of the railways of the Dominion, with reference to the advantages and detriments of government assistance. 3500 w. Engineering Magazine—June, 1898. No. 20473 B.

Earnings.

Favorable Net Railway Returns. A summary of the first quarter of the work of roads in the United States, showing quite satisfactory returns. 1100 w. Bradstreet's—May 21, 1898. No. 20310.

Railroad Earnings Undiminished. Report of earnings on railways of the United States for month of April. 2200 w. Bradstreet's—May 14, 1898. No. 20188.

New South Wales.

Railways in New South Wales. Information taken from the annual Blue Book, compiled by T. A. Coghlan, the government statistician of the colony. The growth and progress of the railways, which are largely under state control, with receipts. 1200 w. Transport—April 22, 1898. No. 19997 A.

LEGAL.

Address.

Address of M. E. Ingalls before the Convention of Railroad Commissioners. Discusses the maintenance of tariffs, and the changes that should be made in the present legislation. 3500 w. Ry Age—May 13, 1898. No. 20225.

Arbitration.

The Federal Arbitration Law. Abstract of the arbitration bill of Senator Kyle which has passed through congress, with brief editorial comment. 1500 w. R R Gaz—May 27, 1898. No. 20524.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Piston Travel, Means of Adjustment and Its Effect Upon the Handling of Trains. Abstract of report to the Assn. of Railroad Air Brake Men, Baltimore meeting. 2700 w. R R Car Jour—May, 1898. No. 20115.

The M. C. B. Standard for Air Brakes. Editorial discussion of the proposed action of the Am. Ry. Assn. in regard to the application of air brakes to freight cars. Reviews the past history and discusses the present situation. 1800 w. Eng News—May 19, 1898. No. 20273.

Locomotive.

Consolidation Freight Locomotive; Southern Ry. Drawings, dimensions and interesting features of heavy engines built by the Richmond Locomotive & Machine Works. 500 w. Eng News—May 5, 1898. No. 20075.

Early Baldwin Locomotives on the Pennsylvania Railroad. Illustrations showing two types built between 1853 and 1856, with information concerning them. 900 w. R R Gaz—May 6, 1898. No. 20104.

Four Cylinder Compound Passenger Engine, London and North-Western Railway. Illustrated detailed description. 900 w. Engr, Lond—May 6, 1898. No. 20235 A.

The Battle of Rainhill. N. O. Whitney. An interesting account of means of transportation in the district comprising Liverpool and Manchester, Eng., with special reference to the success of George Stephenson's "Rocket." 1800 w. Wis Engr—Jan, 1898. No. 20275 D.

M. C. B. Couplers.

A New Standard Needed for M. C. B. Couplers. An editorial review of the history of the M. C. B. coupler and the present situation. 1400 w. Eng News—May 5, 1898. No. 20073.

Motor Cars.

Steam Motor Cars for Minor Railway Lines. Illustrates the combination cars built by the Baldwin Works of Phila., for the C. H. & D. railroad. 1000 w. Ry Wld—May 5, 1898. No. 20362 A.

Train Lighting.

The Dick System of Electric Train Lighting. (Elektrische Zugbeleuchtung, System Dick.) The system uses accumulators charged by a dynamo on one car axle. A full description is given and an account of practical experience on the local railway between Vienna and St. Pölten. 5000 w. Electrotech Zeitschr—April 28, 1898. No. 20452 B.

Truck.

Special Brill Truck for a 96,000-lb. Locomotive Passenger Car. Illustrates a special truck built for a locomotive-passenger car being constructed in France for high-speed electric railway service. 900 w. Eng News—May 19, 1898. No. 20271.

Wheels.

Steel Tired Versus Chilled Iron Wheels. H. M. Boies. A reply to Mr. Sanderson's paper on chilled cast iron wheels. Thinks cast iron cannot be made strong enough or cast drilled wheels uniformly reliable enough to meet the requirement of present railway service. 2800 w. R R Gaz—May 13, 1898. No. 20196.

NEW PROJECTS.

China.

Notes from China. Photographs, with information furnished by Mr. Grant Birch, of the firm of Messrs John Birch & Co., Limited, London, showing the quite respectable amount of railway work in China, and giving interesting facts relating to the different lines. 2700 w. Engng—May 13, 1898. No. 20355 A.

The Position of Railway Development in China. Review of lines existing and projected, with map. 1200 w. Ir & Coal Trds Rev—May 13, 1898. No. 20346 A.

The Railways of China, Existing and Prospective. Andrei Kmita. Reviews the work already completed, and gives information concerning prospective railways. Map. 2300 w. Am Eng & R R Jour—May, 1898. No. 19-986 C.

India.

The Nilgiri Railway. Benson P. Wall. Interesting particulars of a recently constructed mountain railway of India. 2800 w. Ind & East Eng—April, 1898. No. 20288 D.

Railway Widening.

The South-Western Railway Widening at Battersea. Brief account of the widening and bridge building between Vauxhall and Clapham Junction on this English road. 1200 w. Engr, Lond—May 13, 1898. No. 20352 A.

South Africa.

Railway Building in South Africa. Interesting interview with Frank Esmonde White, who has recently returned from Bechuanaland, giving a résumé of the work, its present stage and probable development. 1200 w. Ry & Engng Rev—May 14, 1898. No. 20208.

Trans-Siberian Railway.

The Trans-Siberian Railway: Its New Terminus in China. Clarence Cary. An interesting account of the work thus far accomplished, making a connected steam route run possible, by the use of the Amoor river; and a presentation of existing conditions and the work remaining. 6000 w. Forum—May, 1898. No. 20040 D.

See also Mining and Metallurgy, Gold.

PERMANENT WAY AND FIXTURES.

Boston Station.

Waterproofing and Drainage at the New South Terminal Station in Boston. Some portions of the station lying below high-tide level, has made necessary an extensive covering of waterproof material, and the method adopted is described, with drawings. 800 w. R R Gaz—May 6, 1898. No. 20102.

Crossings.

Railway Crossings in Europe and America. Franklin B. Locke. An interesting illustrated account of recent improvements and of the service in Europe and America, with comparisons and important information. 9000 w. Century Mag—May, 1898. No. 19944 D.

Interlocking.

Releasing Device for Interlocking Plants. Describes a new and interesting form of mechanical release for the electric locks which has been introduced in a plant installed at East Clinton, Ill. Ill. 800 w. Eng News—May 12, 1898. No. 20156.

Joint Station.

Rock Island and Lake Shore Work at Englewood. Illustrates and describes a joint station for three roads to be erected at Englewood (Chicago), in connection with the elevation of

the tracks. 800 w. Ry Age—May 20, 1898. No. 20320.

Paris Railways.

The New Lines of the Western Railway of France. (Les Nouvelles Lignes de la Compagnie l'Ouest.) An account of the new connections of the Western Railway within the city limits and in the environs of Paris; with numerous illustrations and plans. 3500 w. 1 plate. Le Génie Civil—May 7, 1898. No. 20407 D.

Rails.

On the Wear of Steel Rails. G. Olva. Abstract published by the Inst. of Civ. Eng. (British) relating to the life of rails. 1100 w. R R Gaz—May 20, 1898. No. 20298.

Steel Permanent Way. Richard Price-Williams. Read at meeting of the Iron and Steel Inst. (London). Shows that the enormous traffic and tractive power of the present have made steel rails a necessity; that there has been a continued decrease in cost of maintenance of way and rolling stock; calling attention to weak points needing remedy. Discussion. 10200 w. Ir & St Trds Jour—May 14, 1898. No. 20-331 A.

Signals.

An Improved Lever Compensator for Wires to Distant Signals. F. G. Lynde. Discusses the causes of uncertainty in successfully working distant signals and describes a mechanism intended to counteract the defects. Ill. 1500 w. Ind Engng—April 2, 1898. No. 20080 D.

Stresses.

Stresses in Rails Under Moving Loads. P. H. Dudley, in a lecture before the N. Y. Academy of Sciences. Describes the principle and use of the stremmatograph, giving records obtained with it. 2500 w. R R Gaz—May 20, 1898. No. 20296.

Terminal.

The New Terminal Station of the Orleans Railway. (Nouvelle Gare Terminus de la Cie d'Orleans.) An illustrated account of the extension of the road to the quai d'Orsay, and the preparatory demolition works for the new station in Paris. 3500 w. 1 plate. Le Génie Civil—April 16, 1898. No. 20403 D.

Train Motion.

The Motion of Locomotives and Cars on Tangents and Curves. A. Von Borries. Extracts translated from an important work, "Die Eisenbahn-Technik der Gegenwart," by W. W. Nichols. Discusses the quality of the motion, especially as regards the action of the forces developed. 1800 w. R R Gaz—May 6, 1898. No. 20106.

Train Protection.

System for Protection of Railway Trains. Emile Dieudonné. Translated from *La Vie Scientifique*. Brief account of a protecting system devised by MM. Chauvin and Baulan, which enables a stalled train to communicate with neighboring stations, signal towers, etc., or to announce its presence to approaching trains. 1200 w. Elec, N. Y.—May 11, 1898. No. 20186.

STREET AND ELECTRIC TRAMWAYS.

Accumulator Traction.

A Critique of Accumulator Traction. Abstract of a report, giving the conclusions of the deputation of the Blackpool Corporation on Continental Systems of Electric Traction. Conclusions favor the overhead trolley. 1600 w. Elect'n, Lond—April 29, 1898. No. 20146 A.

Algiers.

Electric Traction at Algiers. Description, with interesting photographs, of the first electric tramway in French dominions in Africa, with brief account of previous mode of transport. 1400 w. Ry Wld—May 5, 1898. No. 20361 A.

Aluminum Wires.

Aluminum Wires for Overhead Lines. Stuart A. Russell. Refers to statements made in paper by A. E. Hunt, and gives examples showing that they must be modified when the effect of wind pressure is taken into account. 900 w. Elec Rev, Lond—April 22, 1898. No. 20007 A.

Berlin.

The Electric Railway in the City of Berlin. (Die Elektrische Stadtbahn in Berlin.) M. Foerster. With map, views of elevated structure and details of construction. Serial. 1st part. 3000 w. 1 plate. Stahl und Eisen—May 1, 1898. No. 20445 D.

The Introduction of Electric Power on Berlin Tramways. (Einführung des Elektrischen Betriebes auf den Linien der Grossen Berliner Strassenbahn.) With views of the cars and trucks, showing the arrangement of motors and suspension. 2500 w. Electrotech Zeitschr—May 5, 1898. No. 20456 B.

Booster System.

The Booster System as Applied to Electric Railways. J. Lester Woodbridge. Shows the arrangement of booster, explaining its aim, and operation and discussing the economy. 3000 w. Jour Fr Inst—May, 1898. No. 19947 D.

Connecticut Lines.

Third Rail versus Trolley in Connecticut. Editorial discussion of the rivalry, and the interesting phases of the situation. 1600 w. R R Gaz—May 6, 1898. No. 20107.

Counterweight System.

Counterweight System in St. Paul. Illustrates and describes the system invented by M. H. Bronsdon, which is being installed to replace that part of the cable railway known as Selby Hill. 1500 w. St Ry Rev—May 15, 1898. No. 20204 C.

Earth Returns.

Earth Returns for Electric Tramways. H. F. Parshall. Read before the Inst. of Elec. Eng., England. Considers various types of bonds, welding, and the subject generally, reporting tests and means of preventing electrolysis. 4000 w. Engng—May 6, 1898. No. 20234 A.

Earth Returns for Electric Tramways. H. F. Parshall. Part first reports results of tests showing that a large fraction of the current returns through the earth itself, and presents the necessity of determining the conductivity of the rails, fish plates, and bonds before the track is laid in the earth. Discusses the method of jointing and the composition of the rails, bonds, &c. 2200 w. Elec Eng, Lond—April 29, 1898. Serial. 1st part. No. 20145 A.

Electrolysis.

The Ground Current of Electric Railways. Albert B. Herrick. A discussion of the causes and effects of electrolysis, showing why water pipes and other underground conductors are corroded, together with various methods for preventing such action. 3000 w. Engineering Magazine—June, 1898. No. 20479 B.

English Tramways.

English Electric Street Railroads. Some of the difficulties met by promoters of street railway schemes, the concessions which have been secured, and some that have failed. 1200 w. R R Gaz—May 6, 1898. No. 20103.

Equipment.

New Electrical Equipment of the South Side Elevated Railroad, Chicago. J. R. Cravath. Illustrated description of the interesting features brought out by the change of motive power from steam to electricity. 4300 w. Elec Eng, N. Y.—May 5, 1898. No. 20045.

Germany.

Electric Traction in Germany. Calls attention to some points brought out by Edwin Houswald, in a paper read before the Electro-technical Society of Berlin. Gives a summary of the new features of accumulator working. 1200 w. Engr, Lond—May 13, 1898. No. 20351 A.

Japan.

Electric Railroad Building in Japan. Map of proposed lines in Tokio, with information concerning the companies formed, systems adopted, &c. 800 w. R R Gaz—May 20, 1898. No. 20301.

Jungfrau.

The Jungfrau Railway. (Ueber die Jungfraubahn.) A finely illustrated paper read before the German Railway Society by Dr. Wrubel, giving an account of the preliminary work, plans, rolling stock and motive power of this most important piece of mountain electric railway work. 7500 w. Glaser's Annalen—May 1, 1898. No. 20435 D.

Leeds.

The Cost of Electric Traction: Leeds Electric Tramways. Figures relating to the cost of construction and working of this English line, with editorial comment. 2800 w. Ry Wld—May 5, 1898. No. 20363 A.

Nottingham.

Nottingham Tramways. Report of the Corporation's committee, with critical review. The

committee recommend the adoption of the overhead trolley system, and the reconstruction of the existing system, and many extensions. 4000 w. Ry Wld—May 5, 1898. No. 20364 A.

Paris.

Electrical Tramways in Paris. R. T. Collins. Extract from an article in the supplement to the *Contract Journal*. Illustrated description of the systems in use; the overhead trolley is excluded. 3500 w. Elec Eng, Lond—April 22, 1898. No. 20013 A.

Power Plant.

St. Anthony's Falls Water Power Plant. Illustrated full description of plant constructed to furnish power to all the street railway systems of Minneapolis and St. Paul. 2800 w. St Ry Jour—May, 1898. No. 20039 D.

Power Station.

Power Station of the South Side Elevated Railroad. Illustrated description of this Chicago station for furnishing power to the Sprague multi-unit system recently adopted. 1600 w. St Ry Rev—May 15, 1898. No. 20205 C.

Rack Railway.

The Eisenerz-Vordernberg Railway. (Die Eisenbahn Eisenerz-Vordernberg.) An interesting illustrated description of this combined adhesion and rack railway near Vienna, with profile, topographical map and details of rolling stock. 7500 w. Glaser's Annalen—April 15, 1898. No. 20434 D.

The Electric Rack Railway to the Gorner-

grat. (Die Elektrische Zahnradbahn auf den Gornergrat.) A very full descriptive account of the new road now partially constructed from Zermatt to the Gornergrat, in the Bernese Oberland. Four articles, 8000 w. Schweizerische Bauzeitung—April 16, 23, 30, May 7, 1898. No. 20439 each B.

Reports.

Report of Massachusetts Street Railways. Information from the Railroad Commissioners' report for 1897. 1200 w. St Ry Rev—May 15, 1898. No. 20207 C.

Street Railway Work.

The New Work of the Metropolitan Street Railway Company of New York. Illustrates and describes some features of the electrical construction and station equipment. 1200 w. Elec Eng, N. Y.—May 12, 1898. No. 20167.

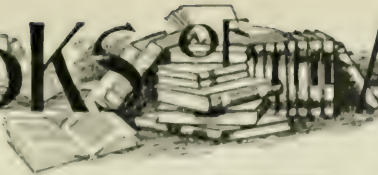
Tramways.

Notes on Electric Tramways. Major P. Cardew, and A. P. Trotter. Read before the Inst. of Elec. Engs., England. Explains a graphical method for determining the fall of potential in the return with uniform distribution of current, and also notes advocating the automatic regulation of this fall of potential. 1800 w. Elect'n, Lond—April 29, 1898. No. 20149 A.

Tubular Line.

The Brompton and Piccadilly Circus Railway. Some facts concerning this deep-level tubular electric line and its connections, with map. 400 w. Transport—April 22, 1898. No. 19996 A.

BOOKS OF THE MONTH



THE RESISTANCE AND PROPULSION OF SHIPS. By William F. Durand, Principal of the School of Marine Construction, Cornell University. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

Since the publication of the great treatises by such men as Rankine and Scott Russell, the greater part of the additions to the literature relating to the resistance and propulsion of ships has been made public in the transactions of scientific societies or in the technical press. For this reason any attempt to collect the data relating to the subject has been attended with much labor and inconvenience, and the results have necessarily lacked coherence and unity.

Professor Durand has worked this mine of information and research to good purpose, and has supplemented the work of others with his own efforts, and the present volume is the result.

Originally intended to serve as lectures to the students in the school of marine construction at Cornell University, the work in its present form suggests the text book, although not to such an extent as to make it unsuitable for reference in connection with the work of the marine engineer and architect.

Starting with the general subject of the resistance to the motion of a solid in a liquid this being very fully and clearly treated, a chapter on propulsion follows, in which screw propellers, paddle wheels and hydraulic jets are given due consideration. The reaction between ship and propeller is next taken up, this being treated mathematically and apart from consideration of constructive details.

The questions of propeller design and the computation of power are discussed successively, and the work closes with a chapter on trial trips.

While a free use has been made of the calculus where the nature of the subject demands it, the book as a whole is much freer from mathematics than others treat-

ing of similar subjects, and makes no greater demands upon the reader's capacity in this respect than any fairly well informed engineering student should be readily capable of meeting. The methods are amply illustrated by examples and the explanations are so clearly given as to render the work a valuable contribution to the science and practice of marine engineering.

THE NEW ROADMASTER'S ASSISTANT. A Manual of Reference for those having to do with the Permanent Way of American Railroads. By George Hebard Paine. New York: *The Railroad Gazette*. 1898.

This is an entirely new work on the lines of the book known as the Roadmaster's Assistant, written twenty-seven years ago by Wm. S. Huntington and afterwards revised by Charles Latimer.

Since the appearance of the original work the changes in methods and materials have rendered many changes necessary in discussing the work of those "having to do with permanent way," and the result is the book now before us.

Mr. Paine has done his work well, and there can be but little doubt that such a book will inspire trackmen to do better work and make better track. The related subjects of water supply, drainage, culverts, trestles, and bridge floors, ballast, cross ties, rails and fastenings, are preceded by general remarks on organization and methods of work, and followed by chapters on tools, emergencies, and signals, with a collection of such simple rules and tables as may be needed. The book is refreshingly practical in every way, and the freedom with which illustrations are used must appeal to the working trackman in a way which no elaborate explanations could ever do. It does seem that with energy, opportunity, and a careful study of this little handbook, almost any man so disposed, could fit himself to become a competent overseer of permanent

way, from the time it is turned over by the contractors to the company.

The work is excellently printed, with wide margins, and marginal "catch notes," so that the subject matter of any page can be taken in at a glance, and the flexible cover, with round corners makes it especially convenient for the pocket.

THE AUTOMOTOR AND HORSELESS VEHICLE POCKET BOOK OF AUTOMOTIVE FORMULÆ AND COMMERCIAL INTELLIGENCE, 1898. Compiled by Geo. Herbert Little, C. E. London: F. King & Co., Ltd. 212 pages. Flexible leather cover.

A decidedly convenient and useful volume; just the thing to be carried in the box of an automotor. It contains an almanac, a log (diary) in which the particulars of a journey may be set down. There are also many appropriate formulæ which we shall not attempt to discuss.

Tables there are, lists of clubs and associations, of individuals, of periodicals and of firms employed in building automotors and automotive materials.

Last, but not least, are the advertisements of which there are many (but not enough) and which should in time prove of the greatest value to a possessor of the book.

HIGH MASONRY DAMS. By E. Sherman Gould. New York: D. Van Nostrand Company. Pasteboard cover. 88 pages.

One is here brought in a very simple manner from the fundamental subject of the static stresses through unit stress, etc., up to the final point — the exact form of the vertical section. This wise little monograph does not, so far as we can see, make use of a single formula which involves an operation more complicated than the extraction of cube root. Thirteen pages are devoted to hints regarding Construction and eleven pages to Accessories, which includes spillways, waste culverts, gates valves and cocks. These last twenty-four pages are entertaining as well as instructive.

The whole eighty-eight pages are simple enough for the student just entering an engineering school and sufficiently conclusive for the practicing engineer.

BOOKS RECEIVED.

Theory and Calculation of Cantilever Bridges. By R. M. Wilcox, Ph. B. New York: D. Van Nostrand Company.

Lighting by Acetylene. By William E. Gibbs, M. E. New York: D. Van Nostrand Company.

Fire Service in Factories, Works, &c. By Harold Sumner. London: The British Fire Protection Committee.

The Metric System of Weights and Measures. By H. M. Lane. Cincinnati, O.: The Manufacturers' Club.

American Cements. By Uriah Cummings. Boston: Rogers & Manson. 1898.

Industrial Electricity. From the French of H. de Graffigny, edited by A. G. Elliott, B. Sc. London and New York: Whittaker & Co. 1898.

A Laboratory Guide in Qualitative Chemical Analysis. By H. L. Wells, M. A. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

A Short Course in Inorganic Qualitative Analysis for Engineering Students. By J. S. C. Wells, Ph. D. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

The New Roadmaster's Assistant. By George Hebard Paine. New York: The Railroad Gazette. 1898.

Exposition Internationale d'Electricité. Règlement et Programmes. Come: Imprimerie Cooperative. 1898.

Fire Resisting Floors used in London. By Frederic R. Farrow. London: The British Fire Prevention Committee. 1898.

Cotton Fires and Cotton Bales. By R. H. Scotter, C. E. London: The British Fire Prevention Committee. 1898.

Preliminary Report on the Income Account of Railways in the United States for the year ending June 30, 1897. Washington: Government Printing Office. 1898.

Annual Report of the Water Commissioners of the City of Binghamton. Binghamton, New York: Binghamton Chronicle.

Third Annual Report of the Metropolitan Water Board. Boston: Wright & Potter. 1898.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

J. Bagshawe & Sons, Ltd., Victory Foundry, Batley, England.=Illustrated price list of wrought iron pulleys, shafting and friction couplings. Practical rules for the transmission of power and safe loads for steel and iron girders are given, as well as particulars of a sand mixing machine.

Andrew Handyside & Co., Ltd., Derby, England.=Handsome photo book of bridges and iron and steel structures. The length of the spans, height and weight of steel work used are given in each case. 30 illustrations.

J. H. Holmes & Co., Newcastle-upon-Tyne, England.=Illustrated catalogues (a) of the "Castle" dynamos and motors for electric lighting; (b) of the "Lundell" continuous current electric motors for power transmission; (c) well printed circular describing the use of the electric motor on printing machinery.

Alley & Maclellan. Polmadie, Glasgow, Scotland.=Well printed and illustrated catalogue of the "Sentinel" (Westinghouse type.) high-speed engine, including information on the repair system, method of operation, and economy. Both simple and compound types are made, and half-tone blocks illustrate the engine applied to pumps, fans, electric lighting, and other plant.

D. A. Rankine, Oriel Chambers, Water St., Liverpool, England.=Circular describing Rankine's patent feed water filters for land and marine boilers. The "Single Cartridge," multiple and compound types are described.

The Kingfisher Patent Lubrication Co., Leeds, England.=Three circulars (a) of automatic screw-plunger lubricators, and of lubricants; (b) of the "Emissary" patent electrical lubricant (c) of jointing cement and preservative paint.

A Keiffenheim & Sons, Prudential Bldgs., Newcastle, England.=Circular giving list of alloys, rare metals and minerals.

Davey Paxman & Co., Ltd., Colchester, England.= (a) Catalogue of steam engines and boilers, including all usual types of pumps, air compressors and mining machinery; (b) Price-list of same.

Lumby, Son & Wood, Ltd., Halifax, England.=Catalogue of the "Pioneer" boiler for hot water and steam heating purposes, describing eight types in all; also useful information for engineers at end. Full dimensions, prices, and description.

Roller-Bearings Company, Ltd., 1 Delahay St., Westminster, London.=Photo book showing the application of roller bearings to railway carriages, tramcars, shafting, etc., with list of purposes to which they have already been applied.

Thomas Henderson, 8 Trueman St., Liverpool, England.=Three circulars (a) describing self-cleaning firebar furnaces, and the "Simplex" patent mechanical stoker; (b) giving results of tests of self-cleaning furnaces applied to marine boilers; (c) describing Henderson's improved mechanical stoker.

R. Robson, 12 Lisle St., Newcastle-on-Tyne, England.= (a) Price list of grindstones; (b) Price-list of cube and flat stones.

Edwin Clark & Co., Ltd., Canal Side, Brimscombe, England.= (a) Catalogue of engines, boilers, valves and fittings, for marine purposes, also of steering wheels, capstans, etc; fully illustrated with dimensions and prices; (b) Illustrated description of Brimscombe district with an account of Messrs. Clark & Co.'s works.

Rosling & Appelby, Bradford, Yorkshire, England.=Illustrated catalogue of dynamos, motors, electrical mining, pumping, hauling and coal cutting machinery. Specifications, prices and sizes are given in most cases.

George Green, Aberystwyth, South Wales. Catalogue of mining machinery, steam engines and boilers, stone breakers, crushing rolls, trommels and jiggers. Full descriptions and illustrations.

The Ipswich Tannery, Ltd., Ipswich, Suffolk, England.=Circular entitled "Comparative Tests of Leather Beltings, also giving prices of the oak bark tanned "Hydra" belting.

Ernest Scott and Mountain, Ltd., Close Works, Newcastle-on-Tyne, England.=Handsome cloth bound catalogue of electrical plant and machinery, arc lamps, projectors, accumulators, as well as of high speed steam engines and auxiliary machinery for ships. Fully illustrated with sizes and prices. A considerable section is given to electrical mining plants.

Barrows & Co., Ltd., Banbury, Oxon, England.=Illustrated catalogue of steam engines, boilers, and agricultural machinery, with description; also detached price list of this machinery.

Dorman, Long & Co., Ltd., Middlesborough, England.=Section book of beams, joists, angles, tees, channels, bulb, angles, and other structural shapes; well bound in stiff paper cover. For each section safe loads, sizes, areas, inertias, and other data are given; also details of box girders and built-up structural work.

Paris, Singer & Co., Manor Street, Clapham, London.=Price list of high speed gas engines and specially light oil motors for cars and cycle work.

F. Reddaway & Co., Ltd., Pendleton, Manchester, England.=Illustrated eight page price list of "Sphincter Grip" armoured hose; also particulars of a high pressure hydraulic coupling, of unions and of gardening requisites.

Wm. Brenton, Ltd., Polbathic, St. Germans, Cornwall, England.= (a) Price list of agricultural machinery, principally corn and root drills; (b) Price list of lock-pin safety bolts, and of carriage lifting jacks.

Wilson & Gillie, New Quay, North Shields, England.=Circular descriptive of specialties in navigation instruments.

The Hoppes Mfg. Co., Springfield, Ohio, U. S. A.=General catalogue of the Hoppes feed

water purifiers and heaters for use either with live or exhaust steam. The construction and action of the heater is explained and a large list of users appended.

Thomson Electric Welding Co., Lynn, Massachusetts, U. S. A.=Handsomely illustrated pamphlet showing apparatus for electric welding, tempering, annealing, brazing, forging, and shaping of metals by means of the methods invented by Prof. Elihu Thomson.

Gorton & Lidgerwood Co., New York.=Modern House Heating. A handsome catalogue of the Gorton side-feed boilers, as arranged for either steam or hot-water heating, with forms of specifications, plans of buildings and much useful information.

The Lunkenheimer Co., Cincinnati, Ohio, U. S. A.=Illustrated catalogue and price list of valves, injectors, whistles, lubricators, oil and grease cups, and steam specialties. A very complete list of standard steam fittings, together with useful charts of dimensions for use in making up plans of piping systems.

Chandler and Taylor Co., Indianapolis, Indiana, U. S. A.=A very beautiful catalogue of high-class automatic cut off steam engines, showing various sizes and designs, with tabulated specifications.

Niagara Radiator Company, Buffalo, New York, U. S. A.=Price list and dimension sheets of the Niagara radiators for use in steam or hot-water heating. Many handsome designs are shown for a variety of uses.

Dearborn Drug and Chemical Works, Chicago, Illinois, U. S. A.=Pamphlet catalogue devoted to (a) lubricating oils for engines and machinery; (b) the treatment of boiler feed water for the prevention of the formation of scale. Directions for submitting samples of feed water for analysis are given, as well as useful data concerning the selection of lubricants.

Stackpole & Brother, New York=Price list and catalogue of surveying instruments, including levels, transits, theodolites, sextants, &c. Detailed descriptions are given of Y level, plain transit and vertical circle transit, with illustrations.

The American Stoker Company, New York.=A finely illustrated catalogue of the American underfeed stoker, showing its application to various classes of furnaces, together with tabulated results of tests, and testimonials from users. A handsome piece of typography and engraving.

General Electric Company, Schenectady, New York, U. S. A.=Pamphlet catalogue No. 9060, illustrating and describing fan motors for direct and alternating currents.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Record of recent construction, No. 5, June, 1898, with illustrations and specifications of locomotives recently completed for railways in various parts of the world.

C. W. Hunt Company, New York.=Two pamphlet catalogues, (No. 9803) describing the Hunt cable railways, as used for handling coal and merchandise; (No. 9806) illustrating the Hunt automatic railway for the mechanical unloading and dumping of coal. Both are handsomely illustrated and contain descriptions of numerous important installations.

Buffalo Forge Company, Buffalo, New York, U. S. A.=Illustrated pamphlet describing a modern blacksmith's shop, as equipped with improved tools, blowers, exhausters, drills, shears, &c., forming a sketch of a 19th century American smithy.

Cincinnati Screw and Tap Co., Cincinnati, Ohio, U. S. A.=Collection of circulars of set and cap screws, stud bolts, nuts, and special bolts; also taps, reamers, and other small tools. Catalogue No. 7 will be sent on application.

Ferracute Machine Company, Bridgeton, New Jersey, U. S. A.=Large illustrated sheet (No. 30) of foot and power presses for stamping and drawing all kinds of sheet metal, giving weights, prices, and brief description.

The Electric Storage Battery Co., Philadelphia, Pa., U. S. A.=Circular No. 40, illustrating the application of storage batteries to isolated plants by describing a residence lighting plant installed in a private mansion at Wayne, near Philadelphia.

J. A. Fay & Co., Cincinnati, Ohio, U. S. A.=Large illustrated sheet, showing woodworking machinery of all kinds, with brief descriptions.

Bingham & Co., Philadelphia, Pa., U. S. A.=Small pamphlet catalogue describing the "Common Sense" exhaust head, for muffling the discharge from exhaust steam pipes, and catching the grease and condensed steam.

The Yale & Towne Mfg. Co., Stamford, Conn., U. S. A.=Handsomely printed pamphlet of "Vulcan" standard locks, composed entirely of wrought metal. A beautiful piece of typography and engraving, showing the construction and operation of the locks in a very clear manner.

THE ENGINEERING MAGAZINE

VOL. XV.

AUGUST, 1898.

No. 5.

THE NAVIES AND NAVAL CONSTRUCTION PROGRAMME OF 1898.

PRESENT TENDENCIES IN DESIGN, ARMAMENT, AND MARINE ENGINEERING.

By H. W. Wilson.

IN the closing decade of the nineteenth century the world is witnessing a remarkable struggle for sea power. The old navies have been reconstructed and immensely increased. New navies of the most formidable proportions have been created. In the case of England the era of naval development opened in 1885, following upon the vigorous propaganda of the *Pall Mall Gazette* under Mr. Stead. In the case of Russia and France the period of great increase began in 1890; in the case of Germany, in 1888. Japan discovered the immense value of a navy to herself in the war of 1894-5, since which she has embarked upon an enormous programme. The strength of the naval movement generally throughout the world could not be better illustrated than by the fact that in the ten years, 1878-1887, the seven chief naval powers launched 49 battleships, while in the ten years, 1888-1897, these powers launched 79. The seven powers had only 7 battleships on the stocks at the close of the year 1887; they had 25 at the close of 1897.

In the present year there has been a further and remarkable development, due mainly, in my judgment, to the feeling that a great struggle for the trade of China is near at hand. Thus Germany has adopted a fixed programme of ship-building, to be completed in six years, at a cost of about £20,500,000,—a scheme rivalling in its magnitude the British naval defence act. Under this the vessels to be built are as follows:

	New.	Replacing obsolete ships.	Total.
Battleships	7	5	12
Large cruisers	2	0	2
Small cruisers	7	12	19
	16	17	33

besides minor craft. By the British naval defence act only ten battle-

Copyright, 1898, by John R. Dunlap.

ships were provided. One most important feature of the present German sextennate is that it provides for the automatic replacement of old ships. The German admiralty holds that a battleship becomes obsolete and ineffective in twenty-five years from her launch, and must then be replaced.

In 1897 France, in great alarm, real or affected, at her naval position, adopted a supplementary programme. Her new construction vote for 1898 shows a very substantial increase (about £1,000,000) on 1897. Her new ships laid down in 1897-8 were as follows:

	1897.	1898.	Total.
Battleships.....	1	1	2
Armoured cruisers, large... 3	3	3	6
“ “ small.. 1	2	2	3
Destroyers	7	0	7
Torpedo boats.....	24	11	35

Her example was followed by Russia, which, in March, 1898, suddenly appropriated a sum of 90,000,000 roubles (about £9,000,000) for an extraordinary naval programme, to be spread over seven years. Subsequent information, from a source which I am not at liberty to disclose, but which is trustworthy, leads to the conclusion that a very much larger sum is to be spent, and the spending to be spread over a very much shorter time. The ships to be laid down in Russia in 1898, excluding those which have figured in previous programmes, are these:

	Baltic.	Black Sea.	Total.
Battleships.....	5	—	5
Armoured cruisers.....	—	1	1
Cruisers	2	2	4
Destroyers.....	28	—	28

But against the above must be set the fact that one battleship of the Sissoi class and one of the Apraxine class appear to have been dropped. Still, the net gain is considerable, and two large battleships for the Black sea fleet, projected since the beginning of 1897, are now either in hand or to be commenced at once. Of the five Baltic battleships three will be built in Russia and two abroad. The order for one has already been given to Messrs. Cramp, of Philadelphia, who are to deliver the ship in thirty months. The order for a second is likely to go to San Francisco.

In England there have been no very special efforts to meet these enormous programmes, and it is certain that, unless steps are very quickly taken, the preponderance of that country will be lost.*

* The day after this was written Mr. Goschen, first lord of the admiralty, promised a supplementary vote.

Her extraordinary programme for 1897 and her ordinary programme for 1898 were as follows :

Battleships	3
Large armoured cruisers.....	8
Destroyers.....	4

And in 1898, for the first time since 1894, her contemplated expenditure on new construction falls below that of France and Russia.* The danger is aggravated by the fact that, though her contemplated expenditure for 1897 was £7,191,000, owing to the dispute in the engineering trade only £4,920,000—or less by £480,000 than the sums spent by France and Russia—was actually expended in that year. Thus she has lost ground, and is still losing.

Far otherwise has been the action of Japan. Recognising that the safety and future of an island State must depend upon its navy, the Japanese government, supported by the Japanese nation, is pushing forward its programme of new construction with the utmost activity. The following new ships appear to have been laid down by Japan, or to be projected for 1898 :

Battleship... ..	1
Armoured cruisers.....	3
Destroyers.....	8
Torpedo boats.....	12

In the United States, where the war with Spain has shown the importance of a great navy, a large programme for 1898 is in hand :

Battleships	3
Monitors.....	4
Destroyers.....	16
Torpedo boats.....	12

Such are the great naval powers' programmes for 1898. It is perfectly plain that great efforts are being made on the continent to overcome England and Japan, and these efforts will be furthered by the drop in the military expenditure of the continental States, and by the increasing necessity of a larger army which England realizes.

The exact naval position of England in relation to France and Russia is difficult to determine. The difficulty arises in the classifications of ships. But by far the best tables as yet placed before the public are those of Lord Charles Beresford, which are framed on a trustworthy principle. One or two alterations have been made to bring them up to date, and Germany and the United States have been included.

* England, new construction vote, £7,638,000.

France, £4,000,000.

Russia, £3,280,000 + the extraordinary appropriation for the year, which cannot be less than £1,000,000, and is probably much more.

Battleships.

Class A. Seaworthy; heavy battery; speed, 16 knots or more; Q. F. armament; displacement of 9,000 tons and more; ten years old or less.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
3 Projected.†	3 Jénas.‡	7 Peresviets.	5 Kaiser Fried- rich III.‡	3 Indianas.
3 Formidables.‡	3 Charlemagnes.	3 Three Saints.		1 Iowa.
6 Canopuses.	1 Henri IV.*	3 Poltavas.	4 Brandenb'gs.	2 Kearsarge.
9 Majestics.	4 Carnots.	2 Sissoi Veli'is†		3 Alabamas.
1 Renown.	1 Jauréguiberry.	1 Geo. Victors		3 New.‡
8 R. Sovereigns.	1 Brennus.			
2 Niles.		1 Navarin.‡		
2 Centurions.				
—	—	—	—	—
34	13	17	9	12

* 9,000 tons.

† Trial displacement, 9,470 tons.

‡ Not yet laid down.

§ Two of these not yet laid down.

|| Five of these not yet laid down.

Class B 1. Modern battleships; ten years old or less, of small size; inferior in radius of action and seaworthiness, but well-protected and heavily armed.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
0	4 Valmys.	1 XII Apostles	8 Siegfrieds.	1 Texas.
—	—	3 Oushakovs.	—	10 Monitors.
—	—	—	—	—
0	4	4	8	11

Class B 2. Battleships more than 10 years old, and not so good in armour or armament.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
1 Sanspareil.	3 Magentas.	3 Sinopes.	0	0
6 Admirals.	1 Hoche.	2 Alexander		
2 Colossuses.	2 Formidables.*	II.'s.		
2 Conquerors.	1 Duperré.			
	2 Devastations.*			
	4 Caimans.*			
—	—	—	—	—
11	13	5	0	0

* Rearmed (in part) or refitted.

Class C. Old battle-ships, rearmed and refitted.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
2 Devastations.	1 Redoubtable.	0	4 Badens.	0
2 Ruperts.	1 Furieux.		1 Oldenburg.	
—	—	—	—	—
3*	2	0	5	0

* Bellerephon omitted, as she was rearmed more than 10 years ago and is 33 years old.

Summary of Effective Line of Battle Ships,

	Britain.	France.	Russia.	Germany.	U. S. A.
Class A	34	13	17	9	12
B1	0	4	4	8	7 to 11
B2	11	13	5	0	0
C	3	2	0	5	0
—	—	—	—	—	—
	48	32	29	22	23

Besides these, England has the old muzzle-loading ships, which have been re-boilered or re-engined recently—Alexandra (4 breech-loaders), Sultan, Monarch, Hercules, Temeraire, and Dreadnought. All these ships are now of great age, but they are good sea-keepers.

Armoured Cruisers.

Class A. Speed 20 knots and more ; protection on the water-line add to guns.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
8 Cressys.	6 Montcalms.	1 Gromoboi.	1 Bismarck.	1 Brooklyn.
	3 Dupleixs.	1 Projected.	2 Projected.	1 New York.
	1 Jeanne d'Arc.			
	1 Dupuy de Lôme.			
8	11	2	3	2

Class B. Speed 18 knots and more ; water-line protected.

7 Auroras.	1 Pothnau.	1 Rossiya.	0	0
	4 Bruixs.	11 Rurick.		
7	5	2	0	0

Class C. Speed under 18 knots.

2 Warspites.	2 Vaubans.	1 Nacchimor.	0	0
		1 Vlad. Monomakh.		
		1 Pam. Azova.		
		1 Dm. Donskoi.		
2	2	4	0	0

Summary of Armoured Cruisers.

	Gt. Britain.	France.	Russia.	Germany.	U. S. A.
Class A	8	11	2	3	2
B	7	5	2	0	0
C	2	2	4	0	0
	17	18	8	3	2

Protected Cruisers.

	G. B.	France.	Russia.	Germany.	U. S. A.
A. Speed more than 22 knots for commerce destroyers....	0	3	0	0	2
B. Large sea-going cruisers, protected gun - positions (case-mates or turrets.).....	10	1	0	5	0
C. Large sea-going cruisers, but not protected on all gun-positions...	11	1	0	1	1
D. Medium cruisers.....	32	7	6	3	6
E. Scouts (17 knots and more)....	32	21	2	3	5
	105	33	8	12	14

Torpedo Flotilla.

Torpedo gunboats.....	33	21	9	4	1
Destroyers.....	96	7	29	9	20
Large torpedo boats (under 10 years, displacement 100 tons or over) ..	16	137	32	32	16
	145	165	70	45	37

Harbour Defence Flotilla.

England, France, and Russia all have numerous old ironclads, small turret ships for harbour defence, and antiquated and small torpedo boats, which can render good service in this direction.

From this table it appears that England is superior to France and Russia in battleships of the largest size, inferior in small modern battleships, much inferior in middle-aged battleships, inferior in the best class of armoured cruisers, greatly superior in protected cruisers, and much inferior in the number of her torpedo craft. At all these points, however, there are compensating features, which it would be unjust to overlook. Her large battleships are generally uniform in type. There is little difference in size, design, armament, and protection between the first thirty ships in her total of class A. A similar uniformity does not exist in the French or Russian ships, though unquestionably Russia is seeking to obtain it. The numerical predominance of France and Russia depends upon classes B 1 and B 2, and the ships of B 1 are generally small, indifferent sea-boats, heavy rollers, and not to be compared in speed or endurance with the Majestic or Royal Sovereign.

Turning now from the comparative strength of the powers to the types which are being built, we notice some striking facts. The tendency everywhere appears to be to build large battleships. Russia seems to have dropped a *Sissoi* and a ship of the *Apraxine* class, both vessels of comparatively small size, which were stated to be projected in 1897. France has discontinued the construction of coast-defence ships, for the *Henri IV*, which is a glorified *Valmy*, a legacy of 1895, and, moreover, a very great advance upon the *Valmy* in nautical qualities. England, after her construction of the two *Centurions*,—extremely weak ships for their size in the matter of armament,—has gone back to large dimensions, and her latest battleships range between 12,900 and 15,000 tons. Japan has advanced from 12,450 tons to about 15,000 tons. The United States alone have been able to get satisfactory results on a comparatively low displacement, their battleships ranging from 10,200 tons in the *Indiana* to 11,500 in the *Alabama*, nor have these results involved, in their case, a sacrifice of nautical qualities. The *Indiana* class, before receiving bilge-keels, were heavy rollers, and in any case are not good fighters in a seaway. But they have stood the test of war well, and most of their defects are remedied in the *Alabamas*, which have a high freeboard forward. The United States still cling to the coast defence ship in its worst form, for their navy department has just decided to lay down four small monitors, regardless of their disadvantages as to speed, coal capacity, and unsteadiness.

The growing sense of the immense value of speed and seaworthiness is leading everywhere to a great increase in the class of armoured cruisers. In some of the latest British and German designs the battleships and armoured cruisers shade off into each other, and it is hard to say where the one class begins and the other ends. Generally the distinction is that the battleship carries four armour-piercing guns and the cruisers only two, while the cruiser has an advantage in speed of two to three knots.

The French armoured cruisers, to be constructed under the new French programme, seem a better compromise than the *Cressy*, on their smaller displacement, and are very formidable ships. They have a narrow end-to-end steel belt, 6 inches thick amidships at the upper level, tapering down to 2.4 inches at each end and apparently at the lower level. Above this belt they have a stroke of 3.8-inch plating. Their battery is weaker than the *Cressy*'s,—two 7.6 inch, eight 6.3-inch, four 3.9-inch, and twenty-two small guns, with two torpedo tubes. The heavier weapons are in 6-inch casemates, or turrets, and a rapid supply of ammunition—a very important point—is secured by fourteen electric hoists. In this direction, it is to be feared, very many of the newest English ships are imperfect, and it was noted in the Channel Squadron, during recent target practice under battle conditions, that to maintain the supply of ammunition to the quick-firers was exceedingly difficult. The engine-power of the six cruisers varies between 19,600 and 20,000 h. p., but this appears to be with forced draught. One of the six, moreover, carries six Temple boilers, which are of a particularly frail type, better suited to torpedo vessels than to large cruisers. These ships have three screws—an advantage over the *Cressy*'s two, as there is greater security against disablement, less power to be transmitted by each shaft, and less force to be developed by each engine. Against this must be set greater complication, and not quite so satisfactory results for the same power as in the twin-screw system. The French cruisers are to be fitted to use liquid fuel.

The recurrence to a large surface of moderate armour, which is so marked in the new cruiser, is as plain in the battleship. If we take the American types, this movement is most distinctly seen. First comes the *Indiana*, virtually a Royal Sovereign, but with a low free-board and with all her heavy guns behind stout armour. In the *Iowa* the armour belt diminishes in thickness, but is longer, and the space above it covered by moderate armour is greater. In the *Kearsarge* and *Kentucky* (singularly misleading illustrations of which and of the *Iowa* appear in the usually faultless *Brassey*) the unarmoured target is very small indeed, and the whole centre of the ship is thoroughly pro-

tected against anything under the finest 6-inch A. P. shot, striking squarely at close quarters. In these ships a 4-inch belt is carried forward to the ram, to protect the bows from injury by small Q. F. projectiles, with the consequences of submersion of the ship's head and emergence of her screws and rudder. This is a wise precaution, and England has adopted it by placing 2-inch nickel steel upon the stems of her Canopus, Cressy, and Arrogant classes. The British 2-inch plating is carried higher up than the American 4-inch; so, though there is a difference in thickness, the weight employed is about the same.

The Alabama class is similar in protective qualities to the Kearsarge. The weight of armour carried by these ships, exclusive of the horizontal deck, is about 2,000 tons, which is considerably in excess of the Canopus-class armour. But against this the British ships have the advantage in speed, habitability, and seaworthiness. In ammunition-supply the British ships have little advantage. They carry more rounds for each of the heavy guns, though the American allowance of fifty per gun is probably ample; but in the supply for the 6-in. Q.F. there is no difference. The tendency to simplify the battery asserts itself in the Alabama class. The 8-inch, an intermediate calibre, has vanished. Even in French ships, which are often, as the *Marine Française* puts it, "veritables museums," this tendency appears. To the author it seems that four calibres will give every type of gun required—12-inch for the attack of armour, 6-in for the destruction of thinly-armoured or unarmoured works, 6 or 12 pounders for the destruction of torpedo craft, and 1 pounders for the tops.

Of the Russian Peresviet type too little is known to enable us to form any clear idea of their protective qualities. They appear to be similar in type to the British Canopus, but are slower. They are also much weaker in their heavy battery. Their coal-supply (2,035 tons) is very large, and shows that Russia has grasped the immense influence which coal-supply will exert in war.

The French type of battleship has many peculiar features, some of which are admirable. In their newest vessels these are the most striking points: high speed; extraordinarily effective protection on the waterline, obtained by an end to-end belt of thick armour, with two armour decks, one at the upper level of the belt, the other at the lower, and a complete belt of thin armour above the thick belt, rising at the bows to a considerable height; two heavily-protected gun-positions, electrically manœuvred; feebly-protected auxiliary battery; excellent arrangement for ammunition-supply. To British eyes their great defect is the gap of absolutely unarmoured side, intervening

between the belt and the auxiliary battery. This invites high-explosive and common shell, and it looks as though the upper part of the ship might be put out of action without the submerged hull being injured. In that case the complete belt and double deck would simply save the hull for the captor.

In the smaller classes small protected cruisers appear to be going out of fashion, except in England, and even her *Pelorus* class is not a very useful type. Its ships are relatively slow and very badly armed. Cruisers of 4,000 to 6,000 tons are still in favour everywhere, and Germany has obtained very fine results with such vessels. Elswick has produced incomparably the best and most formidable ships in this class, and some of the Armstrong cruisers, such as the *Takasago*, *Blanco Encalada*, and *Buenos Aires*, of little more than 4,000 tons, are strong and fast enough to cause a great deal of trouble, even to such ships as the *Powerful*, of thrice their size.

In torpedo craft the torpedo-gunboat is now only a survival, as even the new French ships of this type, which look splendid on paper, have been found unsatisfactory in service. The thirty odd British torpedo gunboats, known in the service as "catchers," are too slow to run down torpedo boats, though they are seaworthy little ships. Their supply of coal is so small that they are a hindrance to any squadron. The destroyer, on the other hand, has established its position, and is now being built on a larger or smaller scale by almost every power. In England, it is true, there has been a halt,—perhaps to ascertain whether turbine-propulsion is applicable. Though England is immensely ahead of any other power in this type, France has numerous large and modern torpedo boats, which, if we can believe the French minister of marine, are every bit as good in narrow waters. British naval officers who have had charge of destroyers would not for one moment admit the fact. The destroyer has proved itself a seaworthy, but very fragile, craft. In war it is probable that one half or one third of the British destroyer squadron would always be laid up in the hands of the dockyard authorities for repairs. But the admiralty and the English torpedo-boat builders must be congratulated upon a great and brilliant success, none the less, while all the best qualities of the young officers in command of these formidable little vessels are stimulated and developed.

One result of the war will almost certainly be a demand for cruisers of very high speed and of great coal-supply, for the purpose of scouting. The Elswick type, with a few less guns and a larger coal supply, would be almost ideal for this purpose, as they can run away from armoured cruisers of the *Cressy* and *Montcalm* type, which will generally be found with a squadron.

THE NICARAGUA CANAL IN ITS COMMERCIAL AND MILITARY ASPECTS.

By Joseph Nimmo, Jr.

IN the interest of public discussion the editor of *THE ENGINEERING MAGAZINE* has asked me to write a rejoinder to the article by Professor Lewis M. Haupt on the importance of constructing the Nicaragua canal. I cheerfully comply.

In his attempt to show the commercial importance of the Nicaragua canal Professor Haupt bases his argument upon certain crude unofficial tables compiled by Mr. F. W. Kelly, of New York, from statistics for 1856 and 1857. These tables appear as appendix matter of an official report to the United States congress submitted in 1866, without a word of explanation as to the manner in which the data were compiled,—an essential requisite of authenticity. Professor Haupt might almost as well have gone back to the conditions which characterized commerce in Roman galleys during the Augustan Age. Since 1857 the maritime commerce of the globe has been revolutionized. The most important changes have resulted from the substitution of iron and steel for wood in the construction of sea-going vessels, the adoption of the screw propeller, improvements in naval architecture and in the construction of steam engines and boilers, the construction of the Suez canal, the construction of trans-continental railroads, and the laying of submarine telegraph cables in all parts of the globe. These achievements have changed the whole course and conditions of international commerce. In the antique tables of 1857, upon which Professor Haupt bases his argument, it is assumed that half of the commerce of Mexico, Central America, and Colombia, the whole of the commerce of Chili, Peru, Ecuador, and China, and the entire commerce of California with the eastern side of the United States, “would pass through the isthmus canal,” making a total ship tonnage of 3,094,070 tons. In the light of the facts hereinafter presented these assumptions appear absurd to the last degree.

After the same inconsequential manner Mr. F. W. Kelly estimated that the saving to commerce resulting from the construction of an American isthmian canal would have amounted to the sum of \$50,000,000 during 1857,—forty-one years ago. Then, upon the basis of this unfounded assumption, Professor Haupt executes a marvelous feat of guessing. Without the slightest reference to the changes which have taken place in the conditions governing maritime commerce during the last forty years, he estimates that this saving would have increased at the rate of one hundred per cent. during each sub-

sequent ten years, and therefore would have amounted to \$200,000,000 during 1897. The professor is as much at fault in his arithmetic as in his prophecy. A commerce of \$50,000,000 in 1857, doubling each ten years, would have amounted in 1897 to \$800,000,000. In the entire range of statistical inquiry I have seen nothing so devoid of reason or logic.

From this visionary and antiquated attempt at discussion I turn to the conditions of the living present. In the light of these conditions, absolutely ignored by Professor Haupt, let us endeavor to determine the range and commercial possibilities of the Nicaragua canal.

1. The city of Manila is situated at about the extreme limit of the assumed possibilities of the Nicaragua route. In a letter dated June 10, 1898, the superintendent of the United States coast and geodetic survey furnished to me the following statement of distances:

From Manila to New York :	Nautical Miles.
<i>via</i> Suez Canal.....	11,565
<i>via</i> Nicaragua Canal.....	11,746
From Manila to London :	
<i>via</i> Suez Canal.....	9,600
<i>via</i> Nicaragua Canal.....	14,680

In coaling facilities the Suez canal route is greatly superior to the Nicaragua route. Besides, the Suez is a sea-level canal, whereas the Nicaragua would involve 220 feet of lockage. These conditions give the Suez route an advantage equivalent to two thousand miles, over the Nicaragua route, in trade between the Atlantic ports of the United States and Manila, and an advantage equivalent to seven thousand miles in the trade between Great Britain and Manila. It is absurd, therefore, to assume that any of the commerce either of the United States or of Europe with Asia would take the Nicaragua canal route.

2. The commerce of Asia and Australasia with the Pacific coast ports of the United States will not involve the use of any inter-oceanic canal. Besides, that commerce is of such a character that in its eastward movement it will be carried over railroads, being composed largely of tea, raw silk, and silk goods.

3. The commerce of Australia and New Zealand with the eastern coast of the United States is relatively small. The conditions of distance, coaling stations, Nicaragua canal lockage, and the fact that a considerable proportion of this trade is carried on in sailing vessels, will inevitably divert such commerce to other routes.

4. The entire commerce of Australia and New Zealand with the countries of Europe will, from the conditions of distance, coaling facilities, and the advantages of a sea-level canal, take the Suez route or the route around the Cape of Good Hope.

5. The commerce of the United States with the Hawaiian Islands will for all time be carried on principally through the Pacific coast ports, and chiefly through San Francisco. The imports from Hawaii, principally sugar, will be transported from San Francisco to the interior of the continent and farther east chiefly by rail.

6. From San Diego, California, to Callao, Peru, there is very little commerce—certainly none which could contribute materially to the traffic of the Nicaragua canal. The dividing ridge of the continent being near the Pacific coast, the commerce of Mexico, Central America, and South America naturally turns to the Atlantic coast, and therefore will not, to any extent, become tributary to the traffic of any trans-isthmian canal.

7. South of Callao, the Cape Horn route affords cheaper transportation for the nitrates, minerals generally, and other products of considerable bulk shipped east, than could be afforded by the Nicaragua route with its 220 feet of lockage and tolls. Such cargoes are chiefly carried in sailing vessels, which, for reasons hereinafter stated, cannot pass through the Nicaragua canal. Besides, the Cape Horn route affords to steamers the advantages of touching at intermediate ports on the eastern side of the continent.

8. The traffic of the Panama Railroad furnishes a fair indication of the possibilities of an inter-oceanic canal. The cost of transportation by the route formed by this railroad and connecting steamer lines on the Atlantic and Pacific oceans is not very much, if at all, in excess of the cost which would be incurred by a canal route involving tolls and 220 feet of lockage. If there had been a large and growing demand for traffic by the isthmus route, such demand would undoubtedly have been indicated by an increased freight movement over the Panama Railroad. But there has been no such increase. On the contrary, the amount of freight carried over the Panama Railroad fell from 287,243 tons, in 1884, to 279,197 tons, in 1896. The tonnage of 1896 is insignificant in comparison with the amount of tonnage carried by the trans-continental railroads of the United States, estimated at about 4,000,000 tons annually,—a development since 1869.

9. The trade between the Atlantic and Pacific coasts of the United States undoubtedly presents the largest possibility of traffic for the Nicaragua canal route; but this traffic is subject to the competition of trans-continental railroads, which competition has immensely reduced the demand for traffic by any isthmian route. This is explained as follows. After the opening of the Panama Railroad, January 28, 1855, commerce between the Atlantic and the Pacific coasts of the United States was carried on chiefly by means of steamer lines connecting

New York and San Francisco with the eastern and western termini of that railroad. But, upon the completion of the Central and Union Pacific Railroads, May 10, 1869, the carriage of passengers, mails, coin and bullion, express goods, and the more valuable freights, was at once diverted to the trans-continental lines, and can never again be deflected to any possible trans-isthmian route. During the year ending June 30, 1869, the value of the merchandise transported between San Francisco and New York *via* Panama was \$70,202,029. In the following year the value of merchandise transmitted *via* the isthmus fell to \$18,594,255, and it continued to decline, until it amounted to only \$3,517,582 during the year ending June 30, 1894.

Since the completion of the Union and Central Pacific line in 1869 five other trans-continental railroads have been constructed. Thus an enormous overland commerce by rail has sprung up, not only between seaboard points on the two sides of the continent, but between interior points of the States of the Pacific coast and interior points in the States east of the Rocky mountains; also between seaboard points and interior points east and west of the Rocky mountains. The isthmian route does not, and cannot, compete for these particular branches of the great trans-continental movement. It is, and must for all time remain, exclusively a railroad traffic.

In this connection let us recall the fact that two-thirds of the people of the United States reside west of the Appalachian range. The products of the Pacific coast States will not in the future be transported to Pacific coast ports, thence by sea and canal to Atlantic seaports, and thence by rail to interior points, when they can be transported much more quickly and at less cost directly by rail from points of production to points of consumption.

10. There are now thirteen trans-continental railroads constructed, or in course of construction, on this continent,—namely, the Trans-Andean, of Chili and Argentina, the Panama Railroad, the Costa Rica Railway, the railroad in Nicaragua projected and partly constructed from Corinto on the Pacific coast to an excellent harbor for large ships on the Blewfields river, a railroad projected and partly constructed from Old Guatemala on the Pacific to a port on the bay of Honduras, the Tehuantepec Railroad of Mexico, six trans-continental lines in the United States, and the Canadian Pacific Railway in British America.

11. The railroad is to-day by far the most efficient avenue of either domestic or foreign commerce. The enormous commercial movements across the Atlantic ocean are sustained by connecting railroad lines, the total traffic of which many times exceeds in magnitude that part of their traffic which constitutes exports and imports in ships.

When railroads come in competition with ships, the former, except under peculiar conditions, take the passenger traffic, the mails, bullion, express goods, and the higher classes of freight, and perishable freight requiring quick transit, leaving to competing water-lines the lowest classes of freights of great weight and bulk. Railroads have also, in many instances, superseded water lines in the carriage of the grosser freights by charging rates but little in excess of the actual cost of movement,—a charge oftentimes quite as low as, or even lower than, can be afforded on the water lines. Thus the trans-continental railroads have broken down the traffic between the Atlantic and Pacific ports of the United States around Cape Horn, and reduced to small proportions the traffic *via* the Panama Railroad.

12. The Nicaragua canal would be absolutely unavailable for sailing vessels, on account of lack of wind at either end of the canal. The cost of towing sailing vessels to the canal, through the canal, and for a considerable distance from either end of the canal, in connection with tolls, would constitute an insuperable obstacle to navigating such vessels by the Nicaragua route. That eminent authority in physical geography, Lieutenant Maury, of the United States navy, many years ago pointed to the impracticability of navigating sailing vessels through an American ship canal.

Subsequent observations clearly prove that what Maury said as to the isthmus of Panama, or Darien route, applies with about equal force to both the east and west coasts of Nicaragua. The utter unfitness of the Nicaragua canal route for sailing vessels is confirmed by the fact stated by the United States board of engineers of 1895,—that the rainfall on the Caribbean coast amounts to “nearly twenty-five feet of water a year.” The fact that the direction of this downpour is usually perpendicular to the surface of the earth also indicates the impracticability of the Nicaragua route for sailing vessels.

13. The assumption that the success of the Suez canal route proves that the Nicaragua canal route would be successful is negated by the fact that the Suez canal has no railroad competitor, whereas the Nicaragua canal route, as already shown, would be overwhelmed by the competition of rival lines. One railroad competing with the Suez canal as sharply as do the trans-continental railroads of the United States with any possible American isthmian canal would at once take from it (the Suez canal) the entire passenger traffic and the carriage of the mails, bullion, express goods, and all the higher-class freights and perishable goods. The result of such competition would inevitably be to bankrupt the Suez canal company.

14. The assumption of Professor Haupt that the commerce of the Sault Ste. Marie canal indicates the success of the Nicaragua canal is

equally fallacious. The commerce through that canal is in the nature of barge transfer, between railroads about seven to nine hundred miles apart, in the carriage of enormous quantities of natural products,—chiefly grain, ores, and coal. It is a traffic which has no parallel on the globe.

15. There are also certain facts which bear strong presumptive evidence against the assumed commercial value of the Nicaragua canal,—*viz.*,

First. The proponents of the scheme have declined to discuss its commercial merits, even when it seemed incumbent upon them to do so in their own defence.

Second. These proponents have opposed, and now steadfastly oppose, any thorough and impartial official investigation as to the commercial merits of their route.

Third. These proponents have made strenuous efforts, both in the United States and in Europe, to raise funds to complete that canal as a private enterprise, but have failed in all such efforts, while hundreds of millions of dollars are seeking investment in the money markets of the world. In a word, the Nicaragua canal franchise and property, from the commercial point of view, are to-day practically valueless.

Eighteen years ago, in my then official capacity as chief of the bureau of statistics at Washington, at the request of the American Society of Civil Engineers, I prepared an official report on "The Proposed American Inter-Oceanic Canal in its Commercial Aspects." I found that under then existing conditions it could secure not more than 1,625,000 tons of shipping. In 1895 I made a careful re-examination of my report of 1880, in order to inform myself as to the effect of the events of fifteen years upon the general project of an American isthmian canal, and found that it is unreasonable to assume that more than 300,000 tons of shipping annually would now pass through the Nicaragua canal, if completed.

Professor Haupt assumes that the recent voyage of the Oregon around Cape Horn demonstrates the military importance of the Nicaragua canal. This assumption does not bear the slightest test of scrutiny. According to the highest military authorities, the availability of the Nicaragua canal route for the passage of war vessels would involve the construction of expensive fortifications at either end, and of defences at all exposed points along its line. It would also be necessary, in time of war, to provide an adequate military guard along the entire line,—a distance of about 170 miles, in a foreign country; also an adequate naval force at either end. All this would be required in order to prevent the destruction of the canal at a hundred vulnerable points, to prevent the sinking of ob-

structions at the entrances to the small artificial harbors at either end of the canal, and for defence against formidable naval and military assault. If the Nicaragua canal had been completed a year ago, such protection of it would have cost twenty times as much as sailing the Oregon around South America. Besides, the necessary defence of the canal would have greatly hampered both the army and navy of the United States, in the performance of mere guard duty, at a most inopportune time. To have attempted to pass the Oregon through the Nicaragua canal without such precautions would have been much more hazardous than the experiment of hitching the Maine to a buoy designated by the Spanish authorities in Havana harbor.

The barrier to navigation interposed by the American isthmus from Mexico to South America affords vastly greater military advantages to the United States than would any artificial channel through it, having a width of only about 250 feet at the surface, especially in view of the fact that men and material of war can be transported across the continent by rail,—a privilege denied to other powers.

The assumed need of an isthmian canal for military purposes is obviated by the fact that an adequate force of naval vessels can be constructed for the perfect defence of our Pacific coast ports at one-tenth the cost of the Nicaragua canal. Such naval force would be ever present, and therefore much more reliable as a means of defence than the shifting of great naval vessels from one side of the continent to the other in time of war.

The importance of proceeding cautiously, and upon the basis of a thorough knowledge of all the commercial and military conditions involved in the proposed Nicaragua canal scheme, is emphasized by the fact that three enlightened nations of Europe have in recent years blundered egregiously in regard to the construction of canals of great cost and magnitude. The canal from Liverpool to Manchester is a blunder and a dismal failure. The Kiel canal, of Germany, has—according to the latest returns which I have seen—secured only about one seventh the tonnage predicted for it. Besides, it is of doubtful military value. The Corinth canal of Greece—one of the favorite schemes of Nero and for centuries the dream of commercial writers—represents to-day little else than money thrown away.

The congress of the United States has hitherto confined its attention almost exclusively to the diplomatic and engineering aspects of the proposed Nicaragua canal, and has not investigated or ordered any official investigation of its commercial merits.

I plead for a thorough and impartial official investigation both as to the commercial and military aspects of the proposed Nicaragua canal, by a commission appointed under resolution of congress.

AN EXAMPLE OF SUCCESSFUL JETTY CONSTRUCTION ON THE PACIFIC COAST.

By Gwynn A. Lyell.

SAN Francisco bay is the only natural harbor on the Pacific coast, between the Mexican boundary and the straits of Juan de Fuca, where human agencies have never been called into requisition to improve the entrance. All of the navigable streams on the Pacific coast have been more or less hampered by large areas of sand bars, projecting across their entrances, having in some instances a shifting range of two miles or more, usually north and south, with two or three channels of uncertain depth dividing the outflow. Wherever the needs of commerce and population have justified it, the general government has undertaken the improvement of these entrances, having been in some instances partly successful, but only in one instance entirely so,—*viz.*, the entrance to the Columbia river. This great improvement, so successfully completed, is selected as an example for description.

The Columbia river enters the Pacific ocean between a rocky headland, Cape Disappointment (Hancock), on the north, and Point Adams, a low sand spit, on the south, distant from Cape Disappointment 6 miles. The river is about $3\frac{1}{4}$ miles wide opposite Point Adams. The outermost point of Cape Disappointment extends into the ocean about $3\frac{1}{2}$ miles west of Point Adams, which affords protection to the entrance during northerly winds. Prior to the improvement, three channels of variable depths existed, their location shifting through an angle of about 180 degrees. The main bar channel varied from nineteen to twenty-one feet in depth, and was totally inadequate for the growing demands of commerce.

Violent storms occur along the coast, the most violent coming from the southeast and lasting for several days. The westerly winds have a long fetch, and the waves, in extremely stormy weather, comb and break in five fathoms. The United States coast and geodetic survey charts show that, eight to ten miles off the mouth of the Columbia, currents are directed by prevailing winds, northerly in summer and southerly in winter. Under the most favorable circumstances vessels drawing more than 22 feet could not cross the bar, and, as most of the vessels entering the Columbia could load to 26 feet, they were compelled to depart without full cargoes.

Two prominent headlands are used as landmarks in making the mouth of the river,—*viz.*, Cape Disappointment and Tillamook Head, the latter twenty miles south of the entrance. Tillamook Head is

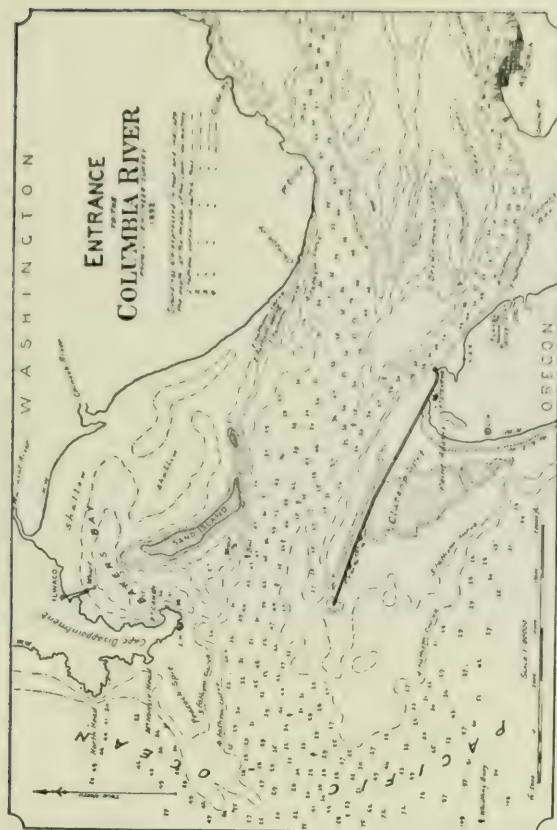
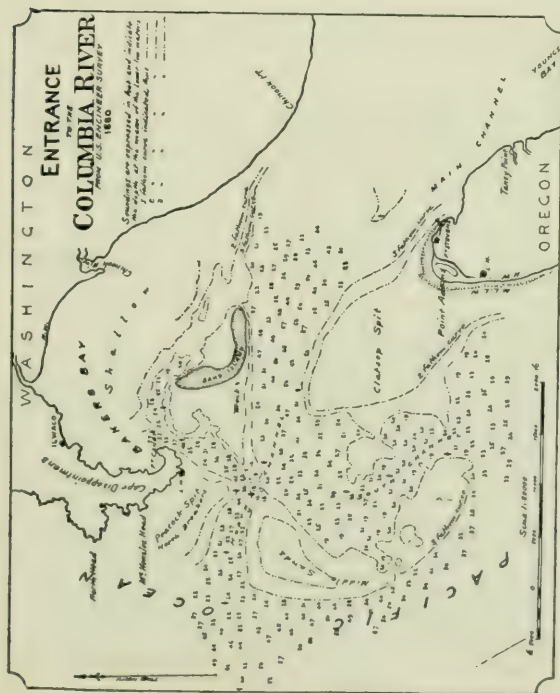


PARADE GROUND, FORT STEVENS.

Showing Jetty and Groins. Cape Disappointment in the Distance.

1,200 feet high, covered with spruce timber, and Cape Disappointment is about 300 feet high and 3 miles long, covered with grass and fern. Point Greenville, a rocky headland, lies sixty miles north of Disappointment, with a low, wide, sandy beach intervening. The bottom of the ocean, for ten miles out, is a hard sand, the average inclination being about five fathoms per mile. The sea breaks at all times in two fathoms, in stormy weather it breaks in five fathoms, and there is evidence to show that it sometimes breaks in ten fathoms. The great current of the northwest coast (the Japan current, or "Kuro Siwo,"), in its passage southward, is about sixty miles off the mouth of the Columbia river. It is said to be about fifty miles wide, and has a black, cold fog hanging over it. Under the influence of the summer northwesterly winds it approaches the main land, and recedes again in winter, under the influence of southerly winds. The currents on the bar undergo constant changes, depending on tides, winds, and outflow of the river. There are strong under-currents, heavy winds make dangerous counter-currents, and the summer floods produce tide rips. There is no slack water on the turn of the tide.

The mean rise and fall of tides at Astoria, twelve miles inland, is 6.2 feet; spring tides, 7.4 feet; neap tides, 4.6 feet. The mean rise and fall of tides at Point Adams is about 7 feet. At low stages of the river the tide is perceptible one hundred and fifty miles from the mouth; at such times the average tidal flow at the mouth for the six hours between the lower low water and the higher high water, is estimated at about 1,000,000 cubic feet per second. The freshwater



*PROFILE OF COLUMBIA RIVER CHANNEL,
FROM ASTORIA TO THE SEA.
Also showing Profile of North & South Channels in 1880*

*Horizontal Scale, 1" = 1000 feet
Vertical Scale, 1" = 100 feet*

CHARTS AND PROFILE OF THE MOUTH OF THE COLUMBIA RIVER.



VIEW OF JETTY BEFORE CONSTRUCTION OF GROINS.

discharge is estimated at about 90,000 cubic feet per second at low stage; at mean low stage, 300,000; in great floods, 1,000,000. But the greatest value is attached to the tidal flow for scour, as it is of longer duration than the discharge proper in the summer floods. A velocity of 4.5 miles per hour has been observed opposite Point Adams.

Having no similar work of such magnitude from which any information as to mode of procedure could be derived, save the construction, then under way, of a jetty at Yaquina entrance, a small estuary about eighty miles south, where the conditions were entirely different, the board of engineer officers appointed to formulate a plan for improvement had a perplexing problem before them. This board consisted of the following officers: Lieutenant-Colonels C. Seaforth Stewart, Wm. P. Craighill, C. B. Comstock, and Captain Chas. F. Powell. They met in San Francisco October 13, 1882. The plan approved by this board consisted in building a mid-tide jetty from the extreme end of Point Adams, on a slight curve convex towards the north, the outer end abreast of Cape Disappointment, and distant therefrom about 3 miles, and $4\frac{1}{2}$ miles from high-water mark at Point Adams. This would contract the waterway abreast of Cape Disappointment, and direct the outgoing waters on the bar, without retarding the inward flow to fill the tidal basin. The jetty was to be built of quarried rock, dumped to place from a narrow-gauge double-track tramway. The estimated cost of the jetty was \$3,710,000; amount appropriated for the work, \$2,025,680. Total

amount expended, \$1,837,057.46, which completed the work according to the approved project.

In 1885, the shops, storage platform for piles, and 3,000 feet of inshore pile trestle, besides other work, were constructed. Piles ranging in diameter from eleven to twenty inches were driven with a jet appliance to depths ranging from fourteen to eighteen feet, through sand and a substratum of mud and decayed vegetable matter. The entire site of the work had to be cleared of a mass of drift-wood, much of which consisted of enormous fir logs imbedded in the sand, some of them several feet below the surface.

For the inshore trestle the pile bents were 12 feet centres, 4 piles to each bent, double track 13 feet centres, 3 feet gauge. Rails were of steel, 30 pounds per yard, fastened with splice bars and spiked to 10 by 14 fir stringers, which were drift bolted to 10 by 12 caps, 21 feet long. This portion of trestle was from 12 to 14 feet above the sand spit, and had a 2 per cent. ascending grade out on to the jetty tramway, to a level of about 24 feet above mean lower low water.

From the root of the jetty, seaward, piles 55 to 70 feet long were driven by the hydraulic process, as it was found impossible to set the piles in the sandy bottom of the ocean by the ordinary process. Four piles per bent, braced transversely at top, with 6 inch square timbers, bolted on; caps 12 inches square, 22 feet long; stringers 12 by 16 inches, 32 feet long, making bent interval 16 feet. A foot plank, 3 by 12 inches, was spiked between the stringers. Double track, 14 feet centres. The stringers were fastened with one inch bolts, 26 inches long.



VIEW FROM RECEIVING WHARF.
Cape Disappointment on Right; also Shore Revetment.



HYDRAULIC REVOLVING PILE DRIVER.

The tramway pile-driver was a specially-constructed machine, fitted with a powerful engine and a large Worthington pump for jetting down piles. The driver made a complete revolution on a turn-table fitted with turned steel rollers. A large tender car accompanied the

driver, mounted on six trucks, three over each track, and carried piles, lumber, etc., for a day's work.

An average of about one thousand feet of double-track tramway could be placed per month, under fair conditions, and partially ripped. Fascine mats were used as a foundation upon which to dump the rock, to prevent its sinking into the yielding sand, and were $2\frac{1}{2}$ to 5 feet thick. The inside mats (those between the bents) were 20 by 64 feet, usually of five thicknesses of fascines. They were made under the tracks, on a platform of piles which formed a part of the mat, the whole suspended from the track stringers above, by ropes fastened to specially-constructed adjustable hooks. When a mat was completed, it was lowered to place, the hooks were moved ahead, and another mat was constructed. The depth of water in which mattresses were sunk ranged from 6 to 20 feet. The outside mats were made inshore, on gridirons, and loaded on flat cars provided with dumping rollers. With a good supply of fascines on hand, two inside mats could be made and placed in position in one day.

For the greater part of the jetty the mattress foundation was 40 feet wide. For the outer 300 feet of the jetty it was 70 feet wide, and over this portion the final dumping consisted almost entirely of rocks, weighing six to twelve tons each.

Four low spur-groins, the outer two 600, and the inner two 1,000, feet long, were built out, perpendicular to the axis of the jetty, on the north or channel side, to counteract the scouring and undermining effect of currents racing along the jetty. In all respects these were built like the jetty.

At the close of the season's work of 1894-95 no appreciable settlement of the enrockment had taken place, but at various points flattening of the section had been effected by the surf, and 2,000 feet of the outer end had been much flattened by repeated storms; this, however, was strengthened, but not fully carried up to the required height.

All work on the jetty was done by hired labor.

To construct the Columbia river jetty, 945,923 tons of rock were used, which cost, including tramway, mattress foundation, plant, transportation, superintendence, etc., an average of \$2.06 per ton of 2000 pounds, and nearly all of which was transported by water a distance of 108 miles. The cost of dumping rock on the jetty averaged about 11 cents per ton,—that is, hoisting from barges and transporting bycars to place of deposit. This included labor, fuel, etc. As before stated, the jetty was practically completed at the close of 1895.

Of piles there were required something more than 377,000 lineal feet, at a cost usually of 8 to 10 cents per lineal foot, delivered at Astoria. The piles in jetty tramway were 55 to 65 feet long, except at



VIEW ALONG AXIS OF JETTY ; LOW TIDE.
Showing Sand Accretion on Left.

the outer end, where 70 foot piles were driven. Over a great portion of the jetty piles were driven in 10 to 30 feet of water.

In times of flood the Columbia carries great quantities of drift, some of it enormous fir logs, and these, being carried back and forth by the tide, played havoc, at times, with the tramway, breaking the piles and otherwise damaging the trestle, all of which added to the cost of maintaining the tramway until it could be sufficiently rip-rapped to protect it.

The tramway, double-track, cost \$6.50 per lineal foot, including all materials, labor, maintenance, etc. Piles and timber in tramway were of Oregon fir. There were used in tramways, wharves, etc., 2,723,473 feet, board-measure, at a cost, usually, of \$10 per thousand.

Of fascines there were used over 22,300 cords, purchased, besides a great many cut on the government reservation. Fascines cost \$2.74 per cord, contract price, delivered at the work. Fascine poles cost 24 cents each. The mattress work, in place, cost \$4.50 per lineal foot.

Steel rails cost \$45 to \$53 per ton, delivered at Astoria. All towing between Astoria and the work was done by the government. Its cost per ton was .034 cents. During the last year of construction an average of 22,355 tons of rock were dumped on the jetty per month.

A building, 30 by 100 feet, was divided into machine, blacksmith, and car shops, for erecting and repairing dump cars, and besides there

was a separate car-erecting shop, 16 by 50 feet. The large shop contained a stationary engine, machine lathes, drill presses, bolt cutters, one blowing fan, and three forges. The engine house had four stalls, with ash pits; conveniently near were coal bunkers, with a capacity of 130 tons of bituminous coal, for use on the locomotives. The other buildings were the office, store-room, etc.

There were two pile-drivers,—the jetty tramway driver and the land driver, the latter being used for building the wharf and inshore end of tramway, where the tramway driver could not be used.

There were twenty-two old-style rocker dump cars in use; as the work progressed, these were found unsatisfactory, being too light and requiring constant repairs. A self-righting dump-car was designed, and forty were eventually built. Their capacity was greater than that of the old style; they were also more easily handled, requiring only one man to dump an entire train of ten or more cars. The cost of these cars was about \$450 each; all the iron work, except the castings, springs, and draw-gears, was made in the shops on the work.

There were five locomotives of the Baldwin and Porter type; their weights were 9 to 13 tons. Other rolling stock consisted of five flat cars, three mat cars, and other small cars. On the receiving wharf there were two hoisting engines and derricks, constantly at work, with one hoister and derrick held as a reserve, in case of accident. The hoisters were of the Mundy and Lidgerwood type, with double cylin-



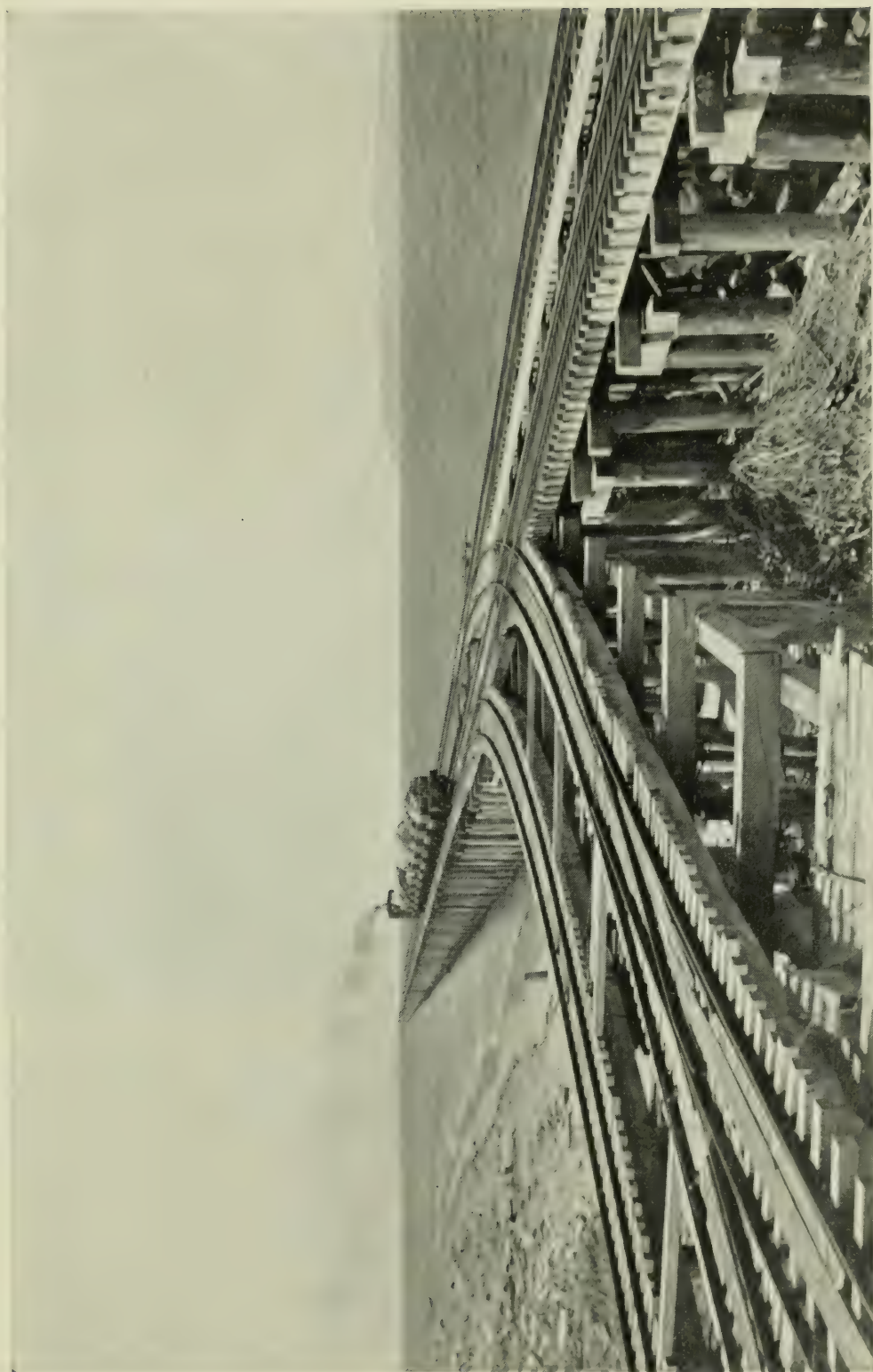
SELF-RIGHTING DUMP CAR RECEIVING ITS LOAD.



TRANSPORTING ROCK.
Tug Geo. H. Mendell Towing Two Barges.

ders, double drums, and vertical boilers. The daily capacity of two derricks was about 600 tons of rock, besides unloading lumber, piles, coal, and other supplies. There were ten model barges employed in rock transportation,—four with a capacity of 280 tons, four with a capacity of 450 tons, and two with a capacity of 295 tons, each. Their cost was \$5,500 to \$5,800 each. For towing these barges a substantial tug, the George H. Mendell, was built by the government, at Portland; length, over all, 90½ feet, beam 18 feet, draught about 7 feet; engines, inverted compound of receiver type, 18-inch stroke; propeller, 5 feet 9 inches in diameter; boilers, Scotch type, 9 feet 3 inches in diameter, 10 feet long, with 124 three-inch return tubes; 2 furnaces, each 36 inches in diameter. The machinery was built by Neafie & Levy, Philadelphia. This boat was very powerful, easily handling two loaded barges against a strong ebb tide. The cost of tug, complete, was \$20,000. It was named in honor of Colonel George H. Mendell, corps of engineers.

In 1893 it became evident that great changes were developing, favorable to navigation. The middle ground, just inside, which had always divided the waters into two channels, had been entirely obliterated. Sand accretion had taken place over a vast area along the jetty. A comparison of the 1885 survey with that of 1892 developed an area, south of the jetty, of 3,200 acres, of triangular shape, over which an accretion, estimated at 30,000,000 cubic yards, had taken place, with an average depth of five feet. At extreme low water



SHORE END OF JETTY. CHANNEL ON THE RIGHT.

about 1,290 acres of this area was bare. The area affected north of the jetty was found to be about equivalent to that at the south side. At the outer limit, or that part next to the channel, which embraced an area of about 1,700 acres, a scouring away of 13,000,000 cubic yards took place. The area next to the jetty at the north embraced 1,500 acres, over which a deposit of 12,000,000 cubic yards took place. The area bare at extreme low water on the north side of the jetty, immediately next to it, was 257 acres. Over the scoured area an average increased depth of 4.41 feet of water was effected. Along the axis of the jetty, sand accumulated with the building-up of the rock above low water, and followed close upon the enrockment as it



DISCHARGING ROCK AT RECEIVING WHARF.

was extended. Over the navigable portion of the new channel the bar survey made in May-June, 1895, developed the following: There was a straight channel across the bar, one-half mile in width, having a least depth of 31 feet, at mean low water. The interval between the 30-foot contours was seven eighths of a mile; between the 24-foot contours, two miles. This survey also showed an increased piling of sand next to the jetty, on both sides. The south spit had an elevation of 6 to 8 feet above the plane of reference; the north spit was bare at a five foot tide. Both spits showed an increased encroachment upon the jetty, being of the same height in many places.

As completed, the jetty, for a length of more than three miles,

was carried up to mean high water,—in many places above that line. (This was authorized by a board of engineers, convened May 27, 1893.) The outer two thousand feet had its height at about mid-tide. The jetty is $4\frac{1}{4}$ miles long. A hydrographic survey of the bar was made in the spring of 1896, and no material changes had taken place in the channel.

Mr. G. B. Hegardt was in local charge as assistant engineer for nearly eight years, and much credit is due him for his untiring energy and skilful management. The object of the work has been most successfully accomplished. The mass of yielding sands, the heavy breakers of the locality, strong currents and winds,—all these have been overcome, and the Columbia river jetty, the longest of its kind in the world, is completed. Some settlement along the line of the jetty has taken place, and was expected, very naturally, in so unstable a foundation. Heavy seas in time of great storms may displace some rock; this is a source of great danger to the jetty, but, as long as the sands continue to pile against the jetty, no displacement is likely to be effected, except at the outer end, which receives the severest shock in storms, and which, as heretofore stated, was greatly reinforced by a wider base and larger rock. The vast areas of sand adjacent to the jetty break the force of the waves before it is reached, and thus protect it.

At the present time (December, 1897) vessels of 26 feet draught can safely navigate the new channel over the bar. British vessels have controlled the foreign trade of the Columbia river for years; they are built of iron, and, in comparison with American wooden ships of the same size, have a greater carrying capacity on less draught, and hence are preferred. It was to the advantage of the shipper and producer to take the vessel of the greater capacity for so long a voyage as that from the Columbia river to Liverpool, the destination of the wheat product.

The value of the principal exports—*viz.*, wheat, flour, and salmon—for a period of ten years ending June 30, 1893, was as follows, yearly average values of each commodity for the period being given:

Wheat, foreign and domestic, value . . .	\$4,485,598.00
Flour, “ “ “ “	2,104,351.00
Salmon, “ “ “ “	2,511,897.00

For the above period, the yearly average value of all exports was \$14,204,608.00. The value of exports for the last four years—*i. e.*, since the channel has been improved—is not attainable. Shipping has increased to a very great extent, and lumber and other shipments have been very large.

NEGLECTED CONSIDERATIONS IN THE ARRANGEMENT OF STEAM PIPING.

By W. Cooper.

THERE are offered in the market to-day a great variety of regularly-manufactured steam boilers, feed-water heaters, filters and purifiers, feed pumps, and mechanical stokers, as well as a great variety of so-called economic appliances,—damper regulators, superheaters, etc. On the steam-generating end of a plant is arrayed this elaborate collection of apparatus, on the development of which much thought and money have been expended. On the steam-using end is arrayed an even more elaborate and complicated line of condensers, engines, reheaters, and various other appliances, intended to get the maximum amount of work out of a minimum amount of steam. When an attempt is made to investigate this mazy array of apparatus with a view of determining the points of merit and demerit, it is found to be almost a hopeless task, owing to the vast variety of combinations.

It seems that, when so much thought and money have been expended upon both ends of the steam plant, at least a small per centage of these might have been given to the connecting link. But, while boilers making steam and engines using it have been developed to a very high degree in the attempts to get the last fraction of a per cent. in efficiency, the link connecting them has been almost entirely neglected. It is assumed that the transmission of the steam from the boiler to the engine is a very simple matter, and that there is no room for improvement over a pipe of sufficient size. It is assumed, again, to be of sufficient size when the velocity of the steam does not exceed a certain number of feet per second, and the calculations of this velocity are based upon yet another assumption.

Here the practice of steam piping seems to have stopped. The fact is, the study of the flow of gases through pipes is a science of no mean degree,—deeper, without doubt, than that of the flow of liquids, as it involves a wider range of varying conditions, on account of the compressibility of the fluid.

That the science of the flow of gases is not yet exact is shown in one of the very latest engineer's hand-books by the deductions from a table on the loss in head in the transmission of compressed air through pipes. From this table it can be shown that it is economical to transmit compressed air at a higher pressure than that required at the outlet, allowing the extra energy stored in the air to escape. In one case a five-fold increase in the terminal pressure decreased the

initial pressure to one-tenth of what it was before the increase of terminal pressure. The error in this case is that the formula used does not take into consideration the fact that the air is compressible. It considers the velocity through the entire pipe to be the same as at the outlet. Since the velocity varies inversely as the pressure, it is evident that it is less at the inlet than at the outlet, for the pressure must be greater to overcome the resistance of the pipe. It is obvious that, if the pressure at the inlet be increased, the resistance to the flow must be increased. This means a longer pipe or higher terminal pressure. In transmitting a given quantity of compressible fluid through a given pipe, the higher the terminal pressure the less the loss in transmission, for the reason that the velocity is less, owing to the increased density. The density of a perfect gas varies inversely as the pressure, and, since the velocity through any given pipe, while transmitting a given weight per minute, varies inversely as the pressure, the velocity varies directly as the density. The loss in head or pressure due to the resistance of the pipes varies as the square of the velocity. If these few cardinal principles are borne in mind, almost any problem may be grappled with successfully. The fallacy of the case cited, where the increase in terminal pressure produced so great a reduction in initial, can be seen by this simple illustration. Suppose that a certain pipe be discharging a certain quantity of compressed air at 60 pounds' pressure per square inch with an initial of 260. The pipe line has been in operation under these conditions for a sufficient time to produce a steady flow through the entire pipe. Suppose the terminal pressure be suddenly reduced to one pound; there is certainly no reason why the initial pressure should increase, but there is a very good reason why it should decrease; less work is being done. The fall in the initial pressure will not be equal to the fall in the terminal, however, for the reason that the mean velocity through the pipe is increased. The loss of head or pressure in the transmission of compressible fluids through pipes increases as the terminal pressure is reduced, but this does not mean that the total initial pressure will be increased. Applying these principles to steam piping, one of the first things of material interest that is discovered is that, as the pressure of the steam used is increased, the size of the steam pipes can be reduced, other things being equal.

In the flow of liquids through pipes there is one factor that does not change; the velocity is uniform throughout the pipe. For a steady discharge there is only one variable factor,—the resistance, depending upon the size and kind of pipes. In the transmission of liquids through pipes the loss of head is a constant, regardless of the pressure, while in the transmission of gas it varies with the pressure. Although

the study of the flow of liquids and gases through pipes with a uniform discharge seems somewhat complex, it is simple in comparison with an intermittent discharge, which sets up in the pipe vibrations and pulsations materially affecting the result. This is, of course, of far more moment in liquids than in gases. The effect of the sudden interruption of the flow is almost exactly the same in either case, and is governed somewhat by the specific gravity of the liquid or gas. The law governing this, however, is not the same in liquids as in gases, owing to the compressibility of the gas.

If the rapid flow of a liquid through a pipe of considerable length be suddenly interrupted, a "hammer" is produced which can easily be made to burst the pipe. In the case of a gas under these conditions the "hammer" is not so violent, but it sets up vibrations which indicate a loss of energy. When the valve on one end of the steam cylinder opens, the steam rushes in, and the whole mass of steam in the pipe is set in motion. The valve closes, and the motion is arrested. The steam, being elastic, recoils, and, while it is on the recoil, the valve again opens, and it again rushes forward, the valve closes, and the cycle is repeated. This recoiling of the steam in the pipe is the power that shakes the pipe and surrounding objects. Where the steam pipe vibrates and shakes, it is proof positive that energy is going to waste.

The vibrating of the steam pipes can be obviated as a "hammer" is obviated where liquids are to be handled with intermittent discharge,—that is, by providing a cushion for it to operate against. This is accomplished, in a pump, by providing a chamber wholly or partially filled with a compressible fluid which absorbs the energy of the momentum of the liquid, returning it to the liquid between discharges. In supplying steam to a steam engine the flow can be made uniform through the pipe, and the inequality of discharge equalized, by providing a chamber of sufficient size immediately at the opening into the engine cylinder. The steam, being compressible, absorbs the energy of the momentum of the flow through the pipe, or, in other words, maintains a constant and uniform flow through the pipe. The action of the steam in this chamber is simply this: when the valve opens into the cylinder, the steam in the chamber expands and fills the cylinder without producing any extra motion of the steam in the pipe. This can be seen by supposing the steam pipe to be cut off from the receiver for the time being. The volume of steam in the chamber would expand, filling the cylinder and reducing the pressure in the chamber in the ratio of the volume of the chamber to this same volume plus the volume of the cylinder. The steam in this chamber expands without producing momentum, because there is no resulting

motion. When steam is supplied to the receiver at a uniform rate, the pressure is never reduced to the minimum, or to what it would be in the case just supposed. The action of the receiver tends to maintain a mean between the maximum and the minimum, and it is obvious, that, the larger this receiver, the less the difference between the mean and the maximum pressure.

In connecting the boilers to the engines the first point to be taken into consideration is the amount of steam to be transmitted. This can be determined approximately by the horse power of the engine multiplied by the probable consumption per horse power. After the amount of steam has been determined, the density can be calculated from the pressure. Knowing the density and the number of pounds per unit of time, the size of pipe can be determined, if the allowable velocity is known. Here the first difficulty is encountered; determination of the allowable velocity for any given case is very difficult.

In almost all cases the size of the steam pipe is either determined by "rule of thumb" or calculated on a certain velocity per second. The former plan is as good as the latter, if the velocity has—as is the case in almost every instance—been assumed. The question really is: what shall be the velocity of the steam through the pipe?

It is generally assumed that the size of the pipe for the engine should be determined by the opening into the throttle. If this be eight inch, then the engine should be piped with eight-inch pipe, regardless of everything else. Great inconsistencies naturally result from this method. One maker may believe that it is more economical to pipe an engine with small pipe, on account of the question of radiation, cost, etc., than to use large pipe. Another maker may believe it safer to make the pipe "large enough." Sometimes, as a result of this, 200 h.-p. engines are piped with the size used by another maker for an engine of 1000 h. p. This is certainly very different from the almost absolute consistency that exists between different makes of engines in regard to size of cylinder, etc.

In many cases the steam pipe is little less than a continuation of the engine cylinder in point of diameter, while in others it seems absurdly small in proportion to the diameter of the cylinder. The first condition comes from the fact that in some cases, where a great drop in pressure has been found between the boiler and the engine cylinder, the natural remedy is to increase the size of the steam pipe. This has been done in many cases by actual change in the piping of the whole plant. In many other cases the engine builder has recommended the use of larger pipe than that used in some other plant in which a similar engine had been installed. Of course better results followed these changes, but in some cases only to a very limited degree. Then, on

the theory that the way to improve on a good thing is to have more of the same kind, the size was increased again, until in some cases it became absurdly large. These inconsistencies prove only that the science of piping is not yet exact. The fact is that in a great majority of cases the pipe is far larger than is necessary.

If it is determined that a certain size of pipe is the most economical for a certain engine working at a certain pressure, a pipe of only half that size is sufficient with twice the pressure. If the size of pipe has been determined for any given case, increasing the length does not necessitate an increase in size, except beyond the point to which the determination has been made. That is, theoretically the size of a steam pipe should increase as it advances. While this is true theoretically, all ordinary cases can be covered by a pipe of uniform diameter.

It has never been definitely determined just how small a steam pipe can be used when all conditions are correct. In the installing of steam piping the first thing to be considered is the size of the receiver. It should be about fifty times the volume of the steam admitted to the cylinder at each valve opening. Under these conditions, if the steam-pipe supply were cut off entirely, the pressure would fall only one-fiftieth of the initial. But, as the steam-pipe supply is uniform under these conditions, it tends to keep up the pressure, and will hold it at a mean between the maximum and the minimum. The receiver should be placed as close to the cylinder as possible, in order to reduce the recoil action to a minimum. With a receiver of this capacity immediately next to the cylinder, the size of the steam pipe to the boilers can be reduced to a point that seems absurdly small. As an illustration, a 1,250-h. p. engine can be run by a pipe 100 feet long and 6 inches in diameter with not more than three pounds' drop in pressure. This seems a small pipe for this size of engine doing nominal or maximum work, and it certainly would be small, were it not for the receiver at the opening into the cylinder. This receiver acts as a reservoir from which the steam admitted to the cylinder at each valve-opening is drawn, thus in no way effecting the flow through the pipe. Under these conditions the drop in pressure will be approximately the pressure required to force the required amount of steam through the given pipe, the loss in pressure being friction alone; no energy is lost in producing vibration and hammer blows in the pipe.

If the drop in pressure between boiler and engine is caused by friction in the pipe, the energy represented by this difference in pressure is absorbed by the steam, tends to superheat it, and saves just that amount of condensation. On the other hand, if the drop in pressure is caused by the pulsations of the steam in the pipe, the en-

ergy represented by this drop is lost, being absorbed by surrounding objects to which the pipe is attached. It is better, then, to err on the side of making the pipe too small than to err by so erecting the pipe that it will be shaken by the recoil of the steam. A velocity of two hundred feet a second can be allowed without producing an uneconomical drop in pressure. It is desirable to obtain the maximum economical drop in pressure.

In installing steam piping care should be taken that the pipe used be as smooth internally as it can be made at reasonable expense. Much of the iron pipe on the market is entirely unfit for steam purposes, as its internal surface is very rough, especially in the small sizes. Steam pipe four inches and more in diameter can be much improved by grinding on the inside. Besides this method, there is a process of glazing that should give very good results. However the pipe is treated, it should be made comparatively smooth on the inside. It need not be polished, but should be free from scabs and humps, and should present a surface on which a film of water will make a complete skin. It will pay handsomely to use such a pipe, even if the cost be doubled. If the pipe be put in this condition, a much smaller pipe can be used in so far as friction is concerned, and the loss from radiation is much less. Given pipe in this condition, there need be but little fear of making it too small. It is allowed that calculating the size from the figured velocity is only educated guess-work, for there are few, if any, reliable data on which to base the assumption of the allowable velocity. If calculations are to be based on guess work, then guess-work will answer as well for the final result. If guess-work is to be the basis of the calculations of size of steam pipe, the guessing should be guided by the knowledge extant. Many instances can be cited, and many authorities quoted, proving that under no circumstances should a velocity of twenty feet per second be exceeded. On the other hand, a few instances can be cited where a velocity of more than seventy feet per second has been used with perfectly satisfactory results. Now, if a single instance can be cited where a velocity of seventy feet per second has been used with economical results, it is proof that this velocity is not too high. It can be shown that, even at a pressure of one hundred and sixty pounds per square inch, it is economical to use a velocity of one hundred feet per second, and this with common iron pipe.

It is not beyond the range of possibilities that a velocity of three hundred feet per second can be used economically, if the arrangement of receivers and the radii of elbows are what they should be.

The science of steam piping resolves itself principally into preventing the energy from leaving the pipe either in the form of heat or of

work which will be turned into heat as it is expended on surrounding objects. If the pipe be covered with a non-conductor, so that the radiation is reduced to zero, and if there is no work being done in shaking pipe and surrounding objects, then no energy is escaping from the pipe. If no energy is escaping from the pipe, and if there is at the same time a drop in steam pressure between boiler and engine, it is a question in the science of superheated steam whether there is a loss in transmission or not. If this be carried to an extreme, there will be a loss. For instance, suppose a non-condensing engine is supplied with steam through a pipe in which the radiation factor is reduced to zero, and that all the pressure generated at the boiler is consumed in forcing the steam through the pipe, so that at the engine the steam has just the pressure of the atmosphere. Under these conditions the steam is highly superheated, but has no power to do work, for there is no pressure to move the piston. It is latent energy, and must be passed through another transformation before it can be made to do work. It is much the same as the latent energy of the coal.

On the other hand, suppose that under these conditions the steam is delivered at the engine just sufficiently superheated to compensate for the condensation in the engine cylinder. Under these conditions is it not reasonable to say that no energy has been lost?

In operating throttling engines it is often found that it is impossible to make steam enough to keep the engine up to speed, if the boiler pressure be kept at the initial pressure in the cylinder, or a little above it, while, if the boiler pressure be doubled, steam can be supplied with ease. This seems almost like a paradox,—like compressing a spring to two pounds to do work, and then allowing it to spring back to one pound before applying it to the work to be done. But there is no paradox about it. The phenomenon can be readily explained on the theory of the steam engine as a heat engine. It is evident that, if the boiler pressure be doubled, more energy is stored in each pound of steam generated. Since the efficiency of the steam engine considered as a heat engine is $\frac{T-t}{T}$, it follows that the heat converted into work

is the sensible heat. Doubling the pressure increases the sensible heat in the steam, and, in the case of a throttling engine in which the pressure is reduced at the throttle, a portion of the sensible heat appears in the form of superheat. If the temperature of the steam entering the cylinder is higher in one case than in the other, it follows that $\frac{T-t}{T}$ is increased; therefore the efficiency of the engine is increased,

other things being equal. It is obvious that, if this superheating be carried to the point where the exhaust is slightly superheated, the

efficiency of the engine, considered as a heat engine, is maximum under the conditions. If the exhaust is superheated to any considerable extent, the efficiency of the apparatus falls off, for latent energy is being wasted.

The science of superheated steam accounts for the good results of many throttling engines. Many throttling engines have shown as high an efficiency as that shown by some automatic cut-off engines. This is due to the fact that the engine uses steam that has been superheated by being "wire drawn" through the throttle valve, thus introducing the energy into the cylinder in a condition to be better utilized than in the case of an automatic engine in which the refrigeration due to excessive expansion neutralizes the advantage of high initial pressure.

Underlying all this is a cardinal principle often overlooked. Energy cannot be annihilated. Then, if no energy escapes from the steam pipe, all the energy of the steam at the boiler must enter the engine cylinder. Whether it enters the cylinder in shape to be utilized or not depends upon conditions.

From the statement that all the energy of the steam at the boiler enters the engine if none escapes from the pipe, it follows that, if no energy escapes from the pipe except in the form of heat, all of the energy of the steam at the boiler must enter the engine, except that lost by radiation. The amount of heat lost by radiation depends upon the difference in temperature between the pipe and the outside air. If the steam be superheated by its passage through the pipe, the extent of this superheating will be so slight that under ordinary circumstances the difference in radiation will be of no account. It is, then, safe to say that there will be no increase in radiation due to superheating. Therefore the same amount of energy per pound of steam will enter the cylinder regardless of the velocity in the pipe, up to the point where the superheating effects the radiation. It is probable that the superheating would be carried to the point where it would affect the temperature of the exhaust before it would materially affect the radiation.

Now, if this superheating does not affect the radiation, and the exhaust is saturated steam, where has any energy been lost? Just where this superheating should cease, and how small the steam pipe should be made to produce the desired result, are difficult points to determine. No attempt will be made here to do this, but it can be stated with a fair degree of certainty that with the highest pressures a velocity of at least two hundred feet per second can be used. It is needless to say that there are many advantages in making the steam pipe small, besides the first cost of the pipe itself. It is easier to erect and provide for expansion, etc., the radiation factor is very

much reduced, and, in general, the cost of installing, maintaining, and operating is less. On the other hand, what is the actual loss in the transmission due to the drop in pressure? If the drop in pressure be caused by the resistance of the pipe only, and this goes to superheat the steam, it is evident that it can be carried to a considerable extent before it will more than offset the saving effected by making the pipe small.

Reasoning from the foregoing, it is evident that in most cases the use of smaller pipe would have produced better results. From the foregoing, too, it might be inferred that, if friction causes no loss in the transmission of the steam through the pipe, it makes no difference whether the pipe be large or small, smooth or rough. To preclude the possibility of such an inference, it may be well to reiterate the principle on which this statement is based. The resistance to the passage of the steam through the pipe superheats the steam. If this superheating does not exceed the amount of condensation in the pipe and engine cylinder, no energy is lost. Thus there is a limit beyond which superheating should not be carried. It is also evident that, the smoother the pipe is internally, the less the resistance, or the smaller it can be made for a given resistance. The amount of drop in pressure allowable in any given case cannot at present be determined. It is stated, however, by a good authority, that about one hundred degrees of superheat will compensate for any ordinary case of cylinder condensation. It is also stated that a superheating of from forty to fifty degrees effects a saving of fifteen per cent.

As the initial pressure is increased, the amount of superheat per pound of pressure of free expansion decreases. It is about two degrees per pound at atmospheric pressure, while it is only four-tenths of a degree at one hundred and fifty. From this it is evident that the drop in pressure in the pipe would have to be large to entirely compensate for cylinder condensation.

On the other hand, as the size of the pipe is reduced, the amount of steam that will pass per second will be reduced; and, if the pressure at the boiler is not increased, the power of the engine will be reduced,—not, however, its efficiency.

The ideal arrangement is an engine designed to use superheated steam of a certain amount of superheat at a certain cut-off, for its nominal load at maximum efficiency, with a boiler designed to generate steam at a pressure so much higher than the cylinder pressure that a reduction in pressure by passing the steam through a small pipe connecting them will give the required pressure and superheat at the engine. The drop in pressure required to give this result is about one hundred pounds with two hundred and fifty pounds at the boiler.

EFFECTIVE SYSTEMS FOR FINDING AND KEEP- ING SHOP COSTS.

By Henry Roland.

THE HYATT ROLLER BEARING COMPANY'S PRACTICE.

ALTHOUGH, speaking generally, one Hyatt roller bearer is similar to another, there are at the present time about two thousand different bearings classified in the Hyatt factory, no two of which are alike in cost ; hence quite as much variety is demanded in keeping the Hyatt factory cost accounts as in any ordinary jobbing machine shop of the same size, while at the same time the apparent similarity of the different lots of work produced very easily leads to an unitemized practice in cost estimates, which, as practical factory accountants well know, is productive of purely guess-work totals of the most misleading character. Indeed, it may safely be said that any cost-keeping system based on assumption at any material point of its practice merely throws away the money which it costs to maintain it, and would better be terminated at once. A cost-keeping system should at least be homogeneous, and, if exact in part, should be exact as a whole, because an imposing array of figures, although based on assumptions which may be far from approximating the actual outlays, is much more impressive to the average mind than avowed guess-work, so that a substantial error in assumed costs carefully carried through an elaborate system of cost books is much less liable to be detected and rectified than if the cost estimate was avowedly the mere conjecture which it always must be if not verified by actual charges of the utmost attainable accuracy.

When Mr. Tellefsen undertook the management of the Hyatt establishment, there was nowhere recorded any accurate information as to the cost of its products. Bearings of certain dimensions were said to cost certain amounts, and were sold at prices based on these asserted costs, which were, in many instances, it is almost needless to say, very far indeed from even tolerably close approximations to the actual figures, as obtained by the use of the three loose blanks and the single cost book which embody the entire machinery of Mr. Tellefsen's cost-keeping methods.

The Hyatt roller bearings are made in a vast variety of diameters and shapes, adapting them for use in machines of almost every description. The bearing consists of soft steel rollers made of coiled flat-steel bars, which travel round and round in a sheet-steel shell made in two pieces with angular margins of junction, confined in cast-iron bearings or hanger boxes of suitable exterior forms. Half of the rollers in each bearing are caged in brass cages, thus en-

HYATT ROLLER BEARING Co., Newark, N. J.		
Their No.....	SHOP ORDER.	Our No.....
Special Instructions	Date	189..
.....	Make for .....	.....
.....	Ship to .....	.....
.....	Via:.....	To be Completed
.....		
.....		
.....		
.....		
.....		
.....		
Completed.....	.....	.....
Invoice .....	.....	Per.....

FIG. 1. OFFICE ORDER TO SHOP.

asuring their own parallelism, and also the parallel movement of the remainder of the rollers, which run free in the journal box.

Fig. 1 is a reduction of the Hyatt office order to the shop. The size of the original is $5\frac{3}{8}$ inches $\times$ $8\frac{3}{8}$ inches, which makes a wide line space, and increases legibility. This card is printed on stiff paper, and has pinned to it when it is sent into the shop the card shown in Fig. 2, size $5\frac{1}{2}$ ins. $\times$ $8\frac{1}{2}$ ins., which is ruled in three divisions, the first for standard stock parts to be drawn on the order from the finished store rooms, the second division for regular castings taken from the rough stores, and also containing space for entries of sundries, while the third division contains in five lines the final cost totals, so that this single card is made to include the final office record of flat cost of materials and labor, and the total cost, with the per cent. additions for shop expense and office expense included ; thus the entire accounting history of the order is contained on this one card, which may, of course, be filed, card-index fashion, in a very small space, so that the card of any order in a year's work, or even more, is instantly accessible. Card filing is, in many particulars, very much to be preferred to a transfer to the pages of a book, as the books are more cumbersome, more expensive, and more difficult of reference. In this card (Fig. 2) all of the shop entries are made by the department foreman. The entries in the final division of six items of totals are made in the office, so that the card serves its two purposes of a current and a final record in a very perfect manner, as it gives no general information, or total cost information, until after the final six entries are made on the card after its return from the shop. This is a highly meritorious combination, and one which is not altogether obvious, in the light of what has been previously detailed in

WEIGHTS OF MATERIALS USED IN

.....BEARINGS.

Order No.....

Order Entered

	Size of Stock	Grade	Size	Weight	Cost	Amount	
Rollers, - -							
Yoke, - -							
Lining, - -							
Sleeve, - -							
Castings, { Brass							
{ Iron							
Sundries, - -							
.....							
.....							
.....							
.....							
Total Cost of Materials Used,					- - -		
Total Amount of Labor, - -					- -		
..... % for Shop Expenses,					- - -		
..... % for Office Expenses,					- -		
Total Net Cost,					- - -		
Amount of Invoice,					- - -		

FIG. 2. COST CARD.

these papers, although it is, in point of fact, exactly analogous to the Strieby and Foote single card. But it is not always the case that we instantly perceive the propriety of following the best practice, even when distinctly pointed out in the conduct of another. The matter tabulated in the final six items of the Tellefsen shop order card is almost invariably separated from the stock card in cost-keeping practice, and is usually kept in a separate book, often locked, and often not in any immediate contiguity to the shop order, although the information contained in the shop order is always an essential part of the conditions leading up to these final totals, and the final totals are often cryptic when read apart from the shop order.

Any degree of privacy in the final disposition of these shop orders after they have been made to include the total costs may be had if they are subjected to card-index filing, as a locked cover to the filing case is just as secure as total cost volumes with locked covers in a locked cabinet.

Having received the office order, as shown in Fig. 1, the shop foreman proceeds to fill the finished-stock and rough material parts of it from the store-room, and to give these requisites, with a workman's time card, as shown in Fig. 3, size 5 ins. $\times$ 8 ins., to the man who is to perform the needful labor on the order. This time card may have the workman's number supplied in the office, if thought desirable; such is the practice in the Hyatt shop, which does not employ so great a number of workmen that the manager has no knowledge of their personality.

It will be observed that the card is made for the full week of seven days, and that it has three lines of special accounts, "New Tools," "Repairs," and "Expense," at its head. As the workman himself fills out this card, he is his own judge of what shall be charged to new tools, what shall be charged to repairs, and what shall go to the "expense" or "shop" account,—three items which can easily be made subjects of controversy even among expert cost accountants. "Expense" is a general item, which may include anything or nothing, and some shop cost keepers abolish "expense" and "shop" entirely from the list of chargeable accounts, asserting that these exchangeable items open the way for a noteworthy percentage of inaccuracies.

"New tools" is rated as an assets item, invariably, while "repairs" are charged in the expense account. Mr. Tellefsen has formulated this theorem: "Whatever is a direct factor in the production of salable goods is an asset;" and he governs himself by this assertion. Hence, if a bar of tool steel is given to the tool smith to forge into lathe and planer tools, these tools are considered assets,

having a value composed of the shop cost of the tool-steel bar and the total cost of the smith's labor. But, when these tools have been worn by use to where they must go to the smithy again, this labor is charged as "repairs," and goes into the expense account. Or, suppose a new boring bar, having a multiplicity of cutters, is made,—such tools being largely used in the Hyatt shops,—the total cost goes into the assets, and is inventoried as a profit item. But repairs on this multiple boring bar, even if these repairs involved an entire new set of cutters, made from new tool steel from the stock room, would be charged as repairs. If the new cutters made of new stock were credited as new tools, it would appear in the inventory that this particular boring bar had two complete sets of cutters, whereas, in fact, it has simply had its worn out original set of cutters made good.

But, by parity of reasoning, it at once appears that, while the number of lathes and planers, say, remains unchanged in the shop, the shop should never be credited in the inventory with possessing more than one set of small tools for each machine tool; hence the forging of new lathe and planer tools, and the cost of the new bar of steel from which these tools are made, should go to the repair account, as expense, instead of into the inventory, as an asset, in case these new tools merely replace old tools which have been worn out. This practice keeps the inventory correct, if small tools are accepted assets. Many factories charge all small forged tools, such as lathe and planer tools, boring-bar cutters, and so on, directly to expense, and there is little question that small drills, files, and hack-saws should go with the oil and waste into the expense. But there is always a feeling that large drills, which are often costly, especially if made above the usual lengths, and which, though speedily worn out if constantly used, last perhaps for years, if used only occasionally, should be regarded as permanent additions to shop equipment, and hence should go into the inventory as assets. Fluted reamers are closely analogous to drills in shop use, yet, unless subjected to much more violent usage than is the common custom, most cost keepers would be inclined to place an expensive set of new fluted reamers among the shop's assets, instead of charging the cost in a lump to expense the day the reamers were delivered to the tool-room. But circumstances alter cases, and, where a fluted reamer is in constant use, as, for instance, in the Baldwin locomotive shops, where a man, in bolting the cylinder castings together, uses no other cutting tool, the reamer is rapidly destroyed, and, rightly enough, is charged directly to expense. Still, even in the case of this severely-used fluted reamer, which is often worn out and replaced, it makes no practical difference whether the first cost is carried on the inventory as an asset, or is

placed at once in the expense account, if, according to Tellefsen's formula only the original tool is credited as an asset, while the frequent replacements of the fluted reamer are charged to expense.

The total drawing-room account is charged as expense, because the making of the drawings of any new bearing always precedes the estimate given to the prospective customer, and, as the possible customer may not make the order finally, it is safe to consider the entire drawing room charges as expense, and be done with the matter.

The pattern-making item is large, and is separately kept. All of the foundry patterns are of cast iron, and the wooden patterns from which the cast-iron patterns are made form a part of the cost of the iron patterns. Since the iron patterns are used directly in the production of salable goods, it follows that the pattern shop account is a credit, and goes into the inventory as an asset.

When the workmen's time cards and the foremen's shop order cards are filled and returned to the office, they are transferred to a flat-cost record book, the size of the page (shown in Fig. 4) being $11\frac{3}{4}$ inches $\times$ $9\frac{1}{4}$ inches. The illustration gives only the left-hand portion of the page, additional order columns extending the width to the $11\frac{3}{4}$ -inch dimension given. The head line is for order numbers, which can be duplicated in adjacent columns, if one column has not room enough. The first line of footing totals is for pattern making, the second for other labor, and the third is for regular items from the finished stores room, with ample space for sundry and unclassified items. The final line of totals gives the flat cost, or prime cost, and from this the total cost is made up of these flat-cost items, the percentages for shop expenses and office expenses being added. These percentages are calculated from previous performances, all records including the value of output for the month in which the performance occurred, which is another form of "number of men in work," and is perhaps the more correct basis of expense apportionment.

The shop-cost items include interest and taxes on realty, depreciation of tools (which is calculated on a basis that always preserves a value), insurance, and repairs. The office expenses include all office and management salaries, supplies, advertising, and travelling and sales expenses.

With these constant expenses, or expenses which, if not constant, may be larger when fewer men are in work and the monthly output is smaller, it is, of course, absolutely essential that the total value of the output for some stated period be selected as a basis of computation, since, in case of a \$5,000 output per month, the expense percentages would be twice as great per dollar of output if the expense remained constant as if the output were \$10,000 for the month. All

of the expenses have been carefully computed for a long series of months, and the expense percentages for shop and office are tabulated with their totals of selling production, and the resultant shop and office cost percentages. For current estimates this preceding tabulation is consulted, a period being selected in which the output of salable product corresponded in value with what is assumed as the probable output of the current similar period. At the end of the year all of these periodic expense percentage assumptions are tested by comparison with the actual expenses, and are invariably found to fall within a wholly insignificant percentage of error. This is what might be expected by experienced shop accountants, who well know the surprising uniformity of expense additions demanded in proportion to the number of men in work, or the total value of output for a limited period of time.

Mr. Tellefsen believes that the error in his estimates averages considerably less than one per cent., and even says that he himself has often been surprised at the close coincidence of his estimates and the actual total costs as shown by the completed account of finished work.

The time card gives the workman's own account of his shop time.

This is mechanically checked by a simple and effective form of time-recorder, so arranged that, by the mere pushing of a button, a record is made, on a ruled sheet, of the time of each workman's entering and leaving, the record being in such form that it can be filed and compared with the time entered by each man in his card.

The importance of a mechanical recorder for workmen's time cannot be over-estimated, especially in connection with any cost system in which the workmen make their own entries on the cost cards, as it eliminates all possible chance of controversy, and a comparison of the mechanical record and the time card filled out by the workman settles every question likely to arise between the men and the paymaster.

A number of effective machines for the purpose of checking the time of entrance and departure are in the market, some being operated by keys, others by stamps, and still others by pressing a button. Even the old method of using metal checks may be used to afford an independent record, which, although made by the men themselves, can be made under such conditions that falsification is impossible. The mere knowledge that such an independent check exists makes the men see to it that the entries on the cards agree with the record.

The Tellefsen cards and cost totals book are applicable to any number of workmen, and three cards and one book contain the entire mechanical part of the system, which thus appears to have the great merits of simplicity and wide adaptability. At the same time, the record kept can be made as full as is desired, any degree of details in account-keeping being practicable.

ORDER NO.										
	Man's No.	Hrs.	Rate	Amount		Man's No.	Hrs.	Rate	Amount	
PATTERN MAKING										
TOTALS										
LABOR										
TOTAL LABOR	Kind or Size	Lbs.	Cost			Kind or Size	Lbs.	Cost		
Rollers										
Compo.										
Lining										
Sleeves										
Cast Iron										
Sundries										
TOTAL COST										

FIG. 4. PAGE OF FLAT COST BOOK.

The department foreman is made accountable for store-room supplies delivered, and the workman records his own fractional time, which must coincide in its total with the mechanical recorder sheet impression also made by the workman himself, instant discharge being placarded as the penalty for touching the button belonging to another workman under any circumstances whatever.

As to estimates, no nearer approximation to accuracy than that afforded by Mr. Tellefsen's method of tabulating previously-ascertained expense percentages for certain outputs in determined time periods seems possible.

No cost-keeping system which is not carefully maintained can be a real aid to exactness, and, if a manager permits a cost clerk to "estimate" even minor totals rather than incur the labor needful to ascertain what such totals actually are, he cannot expect that feeling of confidence which a knowledge of certainties alone can give. But, if any manager of a machine shop will inaugurate the simple system devised by Mr. Tellefsen, and see that its easy conditions are faithfully followed, he will certainly find himself accumulating, day by day and week by week, a knowledge of what he is actually doing that he never had before, and that, too, without a large addition to his clerical force or to his office capacity.

It is an open question whether the workman or a time taker should take the workman's detailed time record. Both methods are largely used, and there are strong arguments in favor of each. It is, perhaps, cheaper for the shop, in first cost, to have the detail time of the workman taken by a time clerk than to have each workman record his own time on a time card, and errors may be written by either method. With workmen of very small education the time card is quite as likely to be correctly filled as where the mechanic has greater clerical ability; it seems more a matter of natural inclination toward business accuracy than of literary acquirements, and some workmen who know but few words of English always fill their cards correctly, while some of the best mechanics are not above frequent errors. Time-takers are also liable to errors and misunderstandings, and, as previously remarked, the question is open, with the weight of greater use in favor of having the workman fill an individual card.

If the workman's self-filled time card is accepted, it is difficult to see how a record of cost items can be brought into the office at less expense than that involved in the use of Tellefsen's cards and a mechanical recorder, or how the record can be completed by less clerical labor than that required to fill the Hyatt flat cost book and add the total cost percentages to the shop order card.

HEATING AND SANITATION OF PUBLIC INSTITUTIONS.

By W. N. Twelvetrees.

IN all large public institutions, and especially in such as are specially devoted to the restoration to health and strength of those who are suffering from disease or other ailments, heat plays a most important part.

The point at which it is generated and from which its power, in various forms, emanates in every direction is the boiler house.

As steam, it is led captive in pipes, to aid in the warming of the surrounding buildings, in the cooking of food for their inmates, in the heating of water for a variety of purposes, and in the operations of cleansing and disinfection.

Among other useful functions it provides the motive power for the generation of electric light, and for the operation of machinery, and for the pumping and distribution of water.

The varied applications of heat in such institutions, forming the object-matter of the present article, may be most conveniently examined by considering the methods adopted in a typical establishment. As affording in every way a complete illustration of our subject, the Brook Hospital, at Shooter's Hill, has been selected.

Erected by the metropolitan asylums board at a cost of more than £280,000, this hospital is probably the largest establishment in the United Kingdom for the care and treatment of those suffering from infectious diseases.

For permission to inspect the hospital the writer is indebted to Mr. Duncombe Mann, clerk to the metropolitan asylums board, and to the medical superintendent, Dr. MacCombie, both for a very courteous reception and for the photographs from which some of the illustrations have been made.

Rising from the low-lying ground which borders the Thames, Shooter's Hill is the most commanding eminence in the north of Kent, and from its summit, crowned by the mimic fortress of Sevedroog, a magnificent view of the surrounding country may be obtained. In the north, beyond the river, are the marshes and the wooded heights of Essex; in the south and east are the verdant slopes of Kent; to the west may be seen the heath-clad hills of Surrey, and the great metropolis.

Various circumstances combine to render the site chosen extre-

mely appropriate for a health-restoring institution, such as the Brook Hospital.

The surrounding district rests upon the chalk formation which extends from New Cross to Dover. Above the chalk, Shooter's Hill, an isolated mass of London clay, surmounted by a thick layer of gravel, rises well above the mists and fogs to which the lower-lying lands near the river are subject. Health-giving breezes are borne across the hills from the open sea, and the purest of water is obtained directly from an adjacent pumping station of the Kent waterworks.

Here, then, are three of the chief essentials for health,—a dry and elevated situation, fresh air, and pure water. Moreover, being built on the south-western slopes of the hill, the hospital is admirably sheltered from both the north and east winds.

In times past Shooter's Hill was not unknown as a health resort, for a mineral spring still existing in the neighbourhood is said to have been used by Queen Anne. John Evelyn, who somewhat appropriately was a commissioner for sick and wounded seamen and a treasurer of Greenwich Hospital, wrote in August, 1699: "I drank the Shooter's Hill waters."

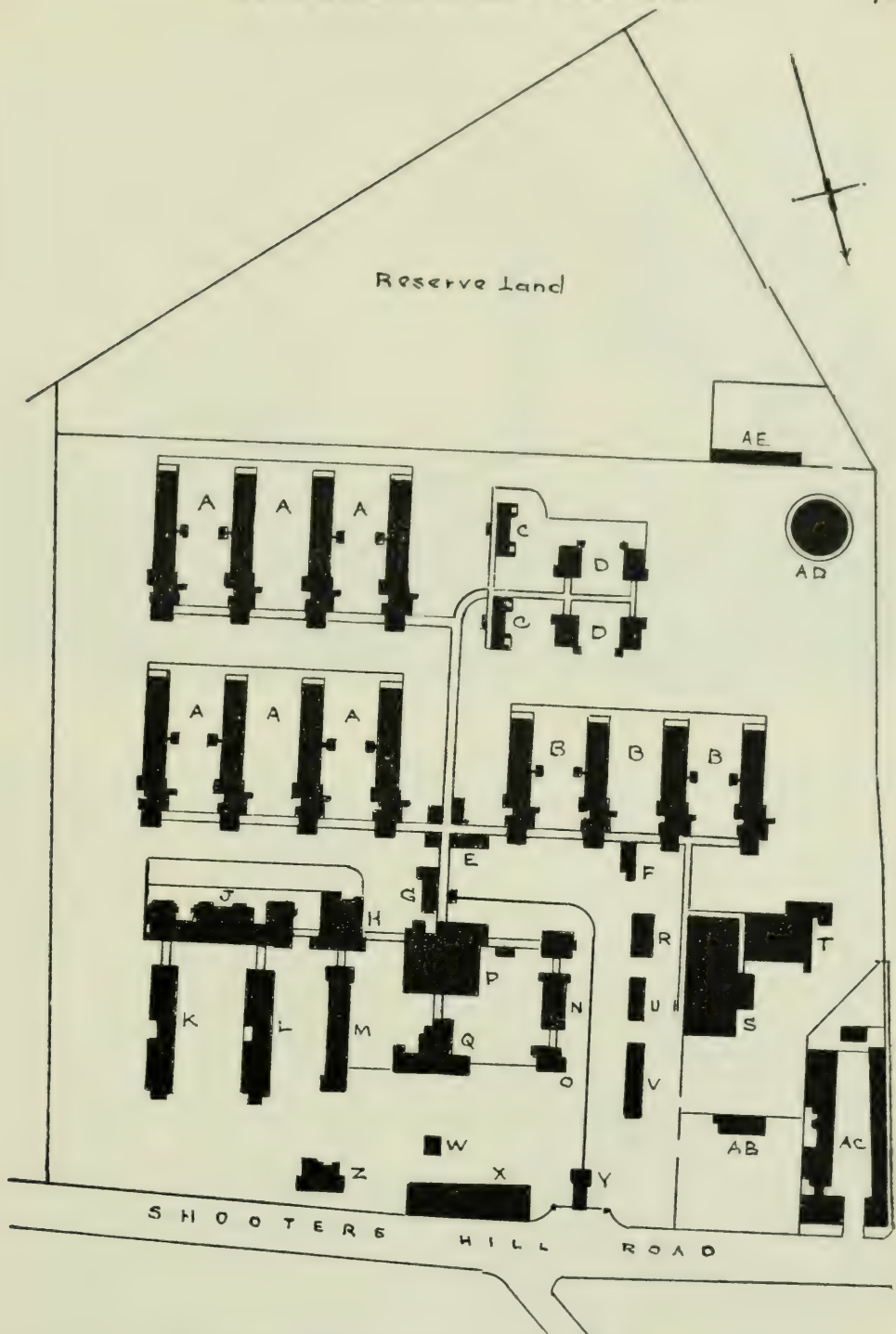
As may be seen from the ground plan which is reproduced opposite, the hospital is practically a village, a small town, symmetrically arranged, and yet possessed of diversity sufficient to present a pleasing general aspect.

The buildings, of red brick throughout, have been designed with especial regard to utility and appropriateness. These are among the first essentials of good architecture, and need by no means be considered inconsistent with true artistic effect.

Although the various pavilions and other buildings are completely isolated, one from the other, they are so admirably linked by covered paths that the visitor is apt to overlook at times the separation which really exists.

Referring to the ground plan, it will be observed that the establishment, which occupies a site nearly thirty acres in extent, contains all the essentials for a complete community. Entering at the porter's lodge, and bearing to the left hand, the steward's house and men's quarters are passed. The residence of the medical superintendent faces the house in which the assistant medical officers and the chaplain make their home, and the block of buildings where the nurses, assistant nurses, and female servants dwell. At the rear of these buildings are the matron's house and sitting-rooms for the nurses, assistant nurses, and female servants.

Administrative offices are situated in the central part of the institution, where also are the dispensary, kitchens, larders, sculleries,



GENERAL GROUND PLAN OF BROOK HOSPITAL.

- | | | |
|--|--|--|
| A Scarlet Fever Pavilions. | J Nurses' Home and Matron's Residence. | U Diphtheria and Enteric Fever Discharge Ward. |
| B Diphtheria and Enteric Fever Pavilion. | K Night Nurses. | V Scarlet Fever Ward. |
| C Single Bed Isolation Wards. | L Assistant Day Nurses. | W Water Tower. |
| D Four Bed " " " " | M Female Servants. | X Pumping Station. |
| E Scarlet Fever Receiving Ward. | N Male " " " " | Y Porter's Lodge. |
| F Diphtheria and Enteric Fever Ward. | O Steward's Residence. | Z Medical Superintendent's Residence. |
| G Matron's Office and Sewing Room. | P Kitchen Stores. | AB Mortuary. |
| H Housekeeper's Rooms. | Q Official Block. | AC Ambulance Station. |
| | R Medical Education Rooms. | AD Rainwater Pond. |
| | S Laundries. | AE Workshops. |
| | T Boiler House. | |



BROOK HOSPITAL, GENERAL VIEW OF BUILDINGS AND POWER HOUSE.

store-rooms, sample-rooms, linen stores, sewing-rooms, etc. These departments practically correspond to the professional chambers, shops, and work rooms found in the outer world, with the important difference, however, that the dispensation of medical advice, of therapeutic agents, of sisterly care and attention, and of nourishing food is unattended by the passing of that desirable commodity, the love of which is stated, on good authority, to be the root of all evil.

Towards the right hand are found departments for medical education, including a lecture-room and laboratory, laundries and the buildings in which are situated the boilers, engines, electric-light plant, engineering workshops, disinfecting apparatus, mortuaries, ambulances, and stables.

At the rear of the hospital buildings there are also smiths', carpenters', painters', and other industrial workshops, rendering the institution practically independent of the outside world, except for the supply of materials.

The general plan provides for the separation of administrative and residential buildings from those in which patients are received. Separate entrance gates are provided for the use of residents, visitors, and those having business at the hospital.

Thus not only are the officials and staff, when not on duty, removed from the usual hospital surroundings, but visitors and other callers need not be exposed to the least danger of infection.

For the reception, treatment, and discharge of patients separate rooms and wards are provided, where diseases are classified, so far as may be conveniently practicable. The main ward pavilions, each two stories in height, with an ample air space under the ground floor, are provided with cooking and all other conveniences necessary, while appliances for regulating supplies of hot water, heat, and light are under ready control by the officials in charge. Each main ward is 120 feet long, 26 feet wide, and 13 feet high, and contains 20 beds. The space allowed per bed is 2,028 cubic feet in scarlet fever cases, and 2,535 cubic feet in cases of enteric fever and diphtheria.

Accommodation exists for the reception of six hundred patients, and, including the staff, the total number of inhabitants, when the institution is full, is nearly 1,000.

In the event of exceptional pressure, temporary wards can be erected on a plot of land included in the grounds, and in this manner a considerable additional number of patients may be received.

Having now obtained a general idea of the arrangement and character of the institution, let us proceed to examine the methods in which heat is applied to minister to the necessities and comforts of its occupants.

As the fountain of all earthly activity is the sun, so, in the minia-



GENERAL VIEW OF BROOK HOSPITAL, SHOOTER'S HILL, KENT, ENGLAND.

The Water Tower is shown on the left.



THE BOILER ROOM AT BROOK HOSPITAL.

ture world under consideration, the main source of heat, light, and mechanical power is derived from a central embodiment. Energy developed in boiler furnaces burning day and night is realised in various forms, and makes its influence felt in every part of the buildings. To this general rule there are two exceptions, inasmuch as gas and fuel are, for some purposes, employed under separate control.

These will be duly considered in their proper places; in the meantime, it is convenient to commence our tour of investigation at the boiler house, which forms part of a block of buildings containing the engines and other important mechanical appliances. The position of the boiler house, therefore, is well chosen, and, if one or two advisable, but comparatively inexpensive, alterations were effected, it would leave little to be desired.

There are three steel boilers of the Lancashire type, each with two flues and fitted with galloway tubes and the usual appliances. The boilers are 30 feet in length by 8 feet in diameter, and are furnished with Henderson's automatic self-cleaning furnaces. Contrary to the practice common in similar installations, no means have been adopted for mechanical stoking, and this operation therefore is performed entirely by manual labour. There is ample room in an adjoining shed for the storage of steam coal, but the space in front of the boilers themselves

might with advantage be extended. The coals deposited there for immediate use are inconveniently near to the boiler fronts, and have to be heaped round the base of a feed-water heater, while the dust, unavoidably raised during stoking, is not calculated to improve a pair of horizontal steam pumps situated in one corner of the stoking department. These disadvantages might readily be obviated by an extension of the boiler-house front and by the removal of the apparatus mentioned to some more suitable position.

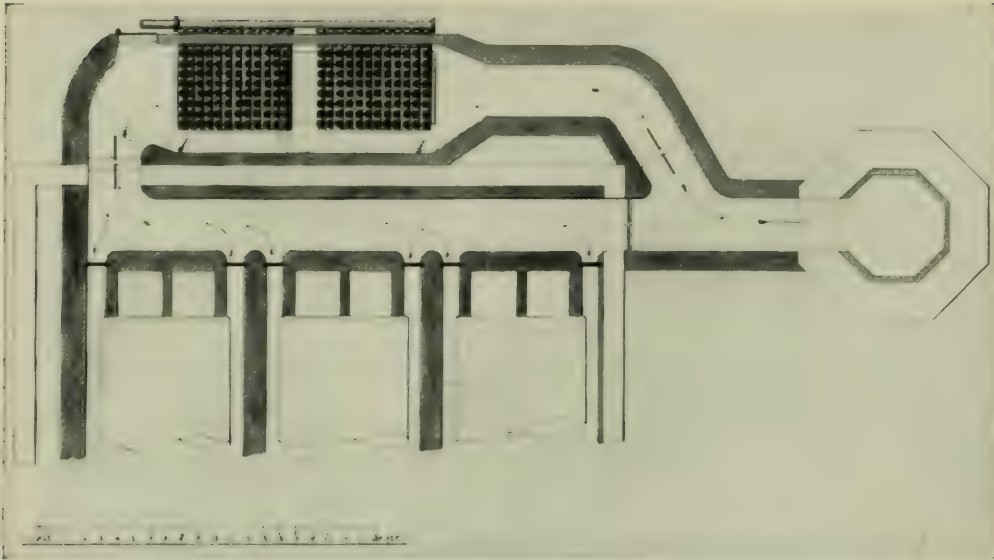
Circumstances such as these serve to emphasise the contention that an architect, however eminent he may be in his own profession, is always well-advised in calling in a properly-qualified engineer to assist in the arrangement and execution of purely engineering work. In this connection it is interesting to note that the metropolitan asylums board "are about to appoint an engineer to advise upon and superintend the various engineering, machinery, drainage, and other works at the several institutions under the control of the board."

The boilers themselves appear to be of excellent construction; they are worked at 125 pounds, pressure per square inch, and are coupled together, so that any one, or all three, may be used as occasion requires. In actual practice two only are used simultaneously the periodical cleaning of each in turn being thus made possible.

Judged by the meaningless, but frequently-adopted, standard, of nominal horse power, each boiler is approximately of about 60 nominal h. p. Of the actual power the writer is unable to speak definitely, but some idea of the power developed may be formed from the consumption of fuel, which at present averages about forty tons per week per boiler, and under times of exceptional pressure has risen to nearly double the quantity. Assuming, therefore, that the boilers possess average evaporative qualities, it will be seen that a very ample margin exists to cover all the variable requirements of the institution.

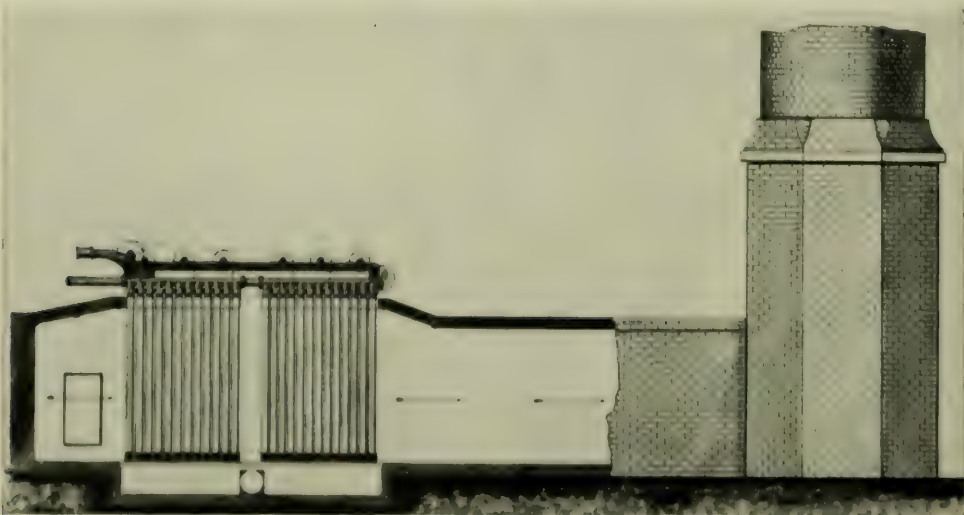
For economising the consumption of fuel various special forms of apparatus have been adopted, one of the most valuable being a Green's Economiser, by the aid of which the feed water may be heated to a high temperature (250° to 300° F.) before entering the boilers, by utilising waste gases from the boiler flues. This apparatus, situated in the horizontal flue connecting the boilers with the chimney shaft, consists essentially of a series of cast-iron tubes (300 in number), each tube being about 4 inches in diameter and 9 feet in length, and all being arranged in sections which are connected by top and bottom boxes, these being again coupled by branch pipes, running lengthwise on opposite sides and outside the brick chamber enclosing the apparatus.

In the present instance feed water is forced into the economiser by

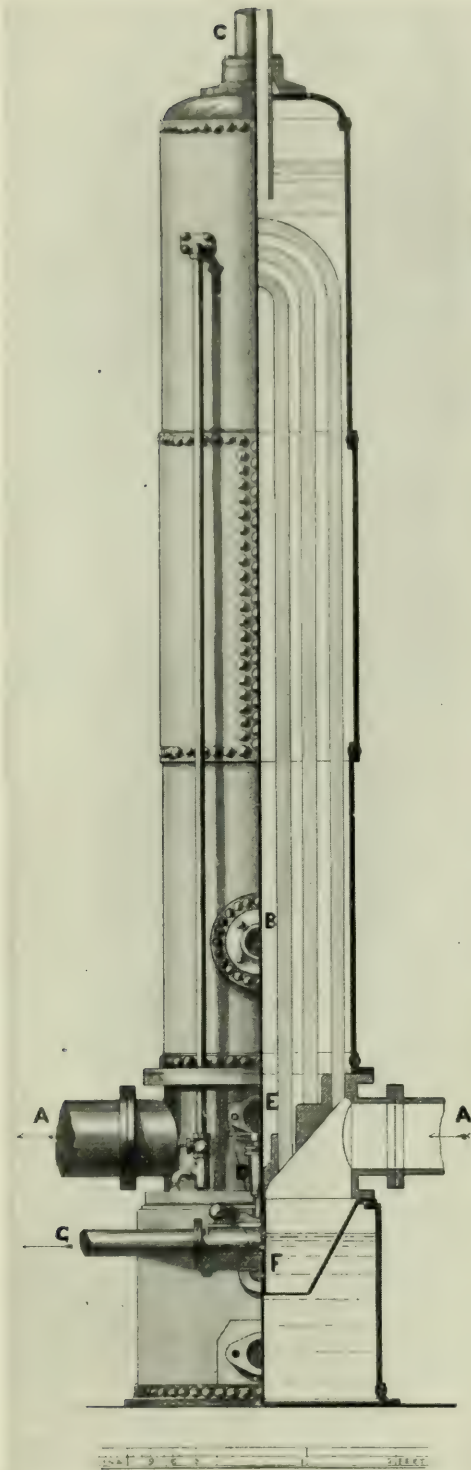


PLAN OF ECONOMISER.

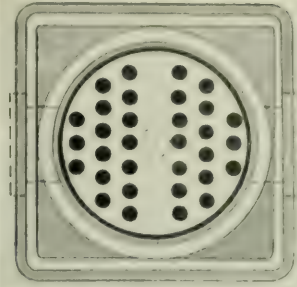
one of the Worthington steam pumps, of which previous incidental mention has been made. The water enters at the lower branch pipe, nearest the exit point of the hot gases of combustion, and emerges at the upper branch pipe, near the point at which the gases enter. As the water tubes are externally exposed to smoke, they would speedily become coated with soot, and consequently less effective for heat transmission, unless provision were made for keeping the surfaces clean. For this purpose each tube is provided with a scraper, which is caused to travel slowly and continuously up and down by the aid of suitable gearing, having an improved form of clutch box for ensuring prompt reversal of the movement at the proper time. Mechanism for working the scrapers is situated on the upper part of the economiser outside



LONGITUDINAL SECTION OF ECONOMISER.



WATER HEATER.



PLAN OF WATER HEATER.

the chamber, motive power being supplied by a small independent engine. Blow-off and safety valves are furnished, and a chamber is constructed at the bottom for the reception of soot removed.

The economy secured by the use of the apparatus varies according to circumstances, but, considering the fact that the products of combustion are, on an average, reduced from 650° F. to about 350° F., it is evident that a very large saving must be effected,—probably 15 per cent. in the case under present consideration.

For the exact determination of the gain in any individual instance the following formula may be used,

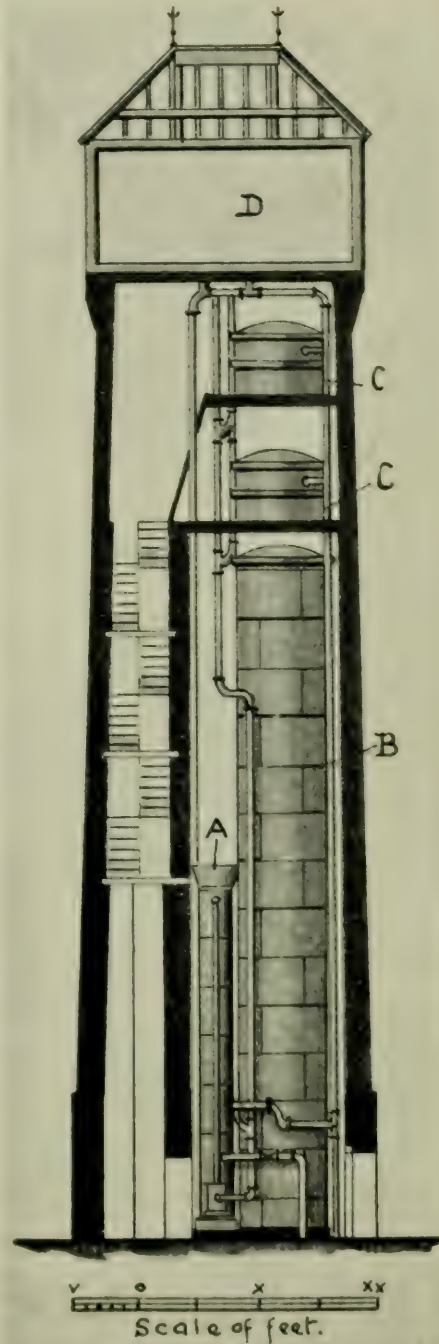
$$G = \frac{100 (T-t)}{H-t},$$

where G represents the saving of fuel per cent., T the temperature of feed water after heating, t the temperature of feed water before heating, and H the total heat (above 0° F.) of the steam at boiler pressure.

A second arrangement provides for the collection and use of water, condensed in numerous

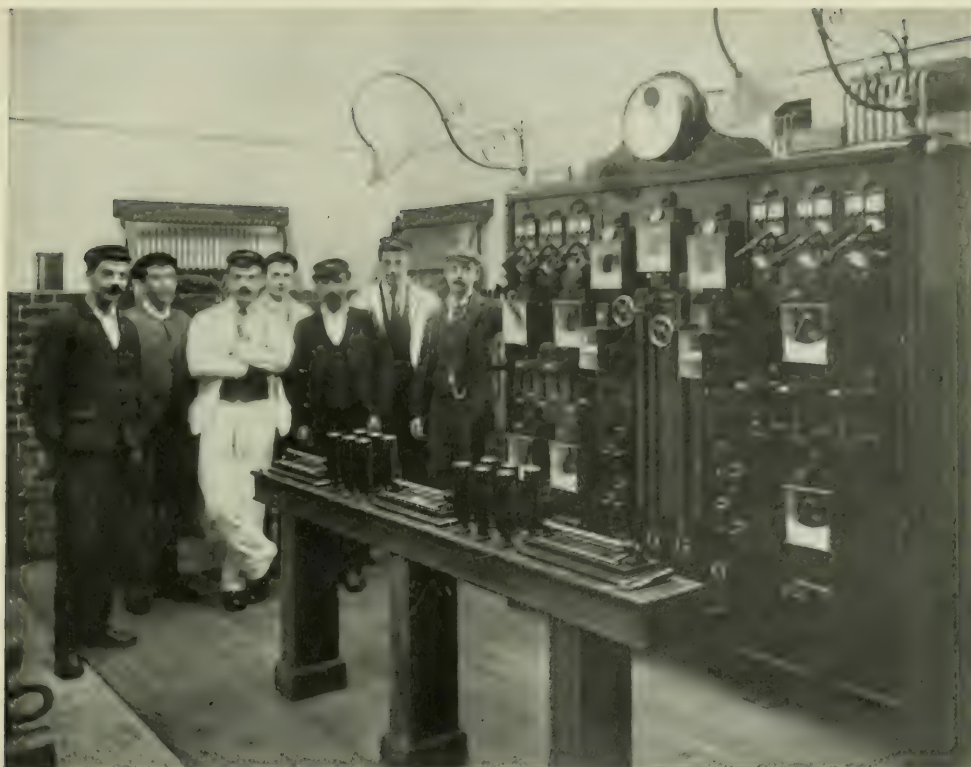
heaters and other appliances all over the hospital buildings. By means of return pipes laid in the subways, such water is delivered into a central reservoir, whence it is pumped to the main feed tank, passing thence through a "Berryman" feed-water heater. This apparatus (already referred to as standing in the stoking space of the boiler house) consists of a vertical boiler-like cylinder about 15 feet in height by 3 feet in diameter. Its internal fittings comprise a series of solid-drawn brass tubes, each length as fixed forming an inverted U, the ends of which are expanded into holes, drilled in a continuous tube plate. Every tube is thus free to expand and contract, independently of the others. Scale does not adhere to the tubes, owing to the difference in expansion between the metal and the scale, and the latter is deposited, together with other impurities, in a siphon chamber forming the base of the apparatus. Exhaust steam from the electric-lighting engines passes into the heater, where practically all of it is condensed in the act of raising the feed water, under pressure, to the boiling-point. The water so condensed is passed through a grease filter, in order that it may be used without injury for boiler-feeding purposes, while an automatic water seal prevents all tendency to back-pressure.

Not only is the heater capable of effecting a saving of about fifteen per cent. in fuel, but the



WATER TOWER, WITH SOFTENING AND FILTERING APPARATUS.

A, Lime Mixing Tower; B, Softening Tower
C, Filters; D, Storage Tank.

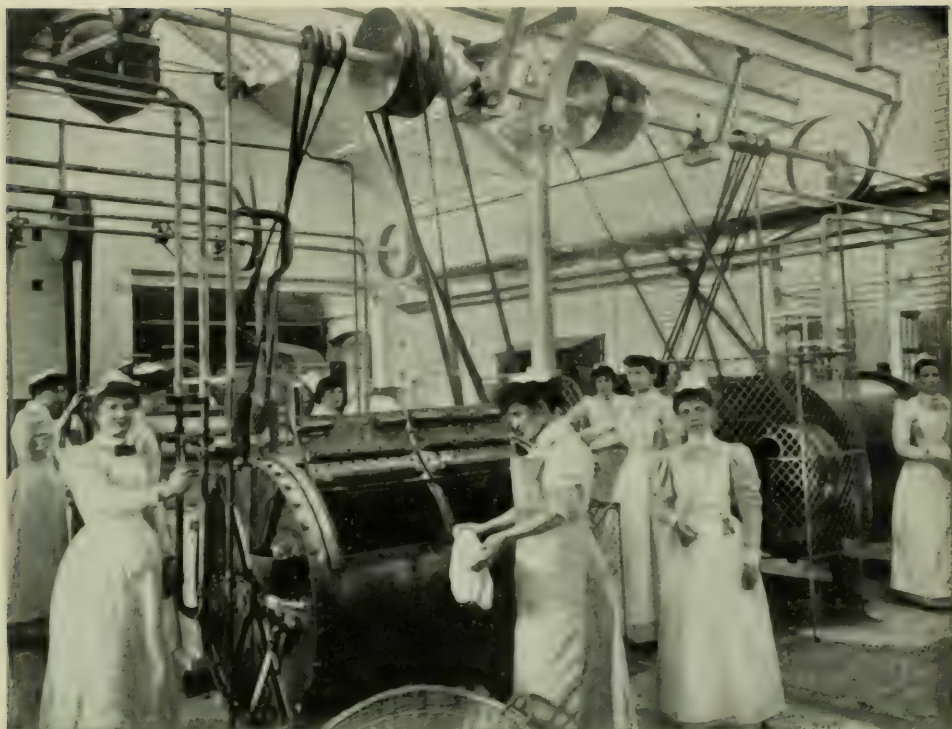


BROOK HOSPITAL ; SWITCHBOARD IN THE DYNAMO ROOM.

quality of the water is improved, owing to the liberation of acid and to the deposition of any earthy salts or other impurity. It is obvious that chemical and mechanical processes, such as these, are preferably conducted in a heater, possessing efficient means of removing the products, than in so costly and comparatively inaccessible a vessel as a steam boiler.

By a third method exhaust steam from the main engine is usefully employed, in a similar water-heater. This time the water heated is delivered into a tank, from which it is drawn for laundry and other purposes. The boiler-feed pumps used in conjunction with the apparatus are of the well-known Worthington type.

Such methods of utilising condensed water and exhaust steam, although perhaps not the most perfect which could be devised, are nevertheless of considerable value, and their importance is more fully realised when it is borne in mind that, even in a theoretically perfect engine, reversible in a thermodynamic, and not in the ordinarily understood, sense, the proportion of steam convertible into mechanical power could in no case exceed 26.2 per cent., while the exhaust steam would represent 73.8 per cent. of the total thermal value of the steam used. These figures are arrived at by the well known second law of thermodynamics, which may be stated as follows :



BROOK HOSPITAL ; WASHING MACHINERY IN LAUNDRY.

$$P = \frac{T + 461 - (t + 461)}{T + 461},$$

in which P = mechanical power, T = temperature of the boiler, t = temperature of coldest of surrounding objects, and 461 = absolute zero.

Upon consideration of the functions performed in the boiler house and elsewhere, it will be seen that the hospital, as a whole, exemplifies a distillation on a large scale. The boiler house represents a huge still, and the buildings grouped around it correspond to the worm or condensing plant, where aqueous vapour, robbed of its latent heat, re-assumes the liquid form and returns to be redistilled. Thus the process continues, hour by hour and day by day, in a never-ending circuit.

From the boilers, steam at a pressure of 125 pounds rises in a main pipe $7\frac{1}{2}$ inches in diameter, which is connected with the main valve of each boiler ; and, after passing a steam dryer or "water-catcher," it enters the separate mains by which it is conveyed to perform its various duties. The pressure existing in the mains is proportioned, by means of automatic reducing valves, to the work to be done. To the engines driving the electric-lighting plant steam is taken at full pressure ; to the laundry and pumping engines, at 60

pounds per square inch. The warming apparatus is supplied with steam at 60 pounds' pressure, the drying chambers are supplied with steam at 30 pounds' pressure, and in the kitchens the pressure is about 5 pounds. The main pipes, in great measure, are laid in subways, so that they may be readily accessible for examination and repair, and their branches extend, in apparently bewildering ramifications, to all parts of the buildings. Altogether, it is estimated that fully one hundred and fifty miles of piping are in use,—a quantity which gives an idea of the magnitude of the operations.

Perhaps one of the most important applications of heat in a hospital for the sick is the provision of means for warming and ventilation. The quantity of heat generated, as the result of a very moderate amount of exercise by a healthy person, amounts, in the course of eight hours, to 2,667 heat units, sufficient to raise 2,667 pounds of water by 1° F., and the heat produced by the chemical action due to respiration averages no less than 6,814 heat units *per diem*, or a quantity sufficient to raise 6,814 pounds of water by 1° F. The sick entirely lack the former source of heat, and enjoy the latter only in a less degree. Therefore artificial means of warmth become necessary, and arrangements must also be provided for ensuring ample supplies of fresh air to remove vapour, exhalations, carbonic acid, and other impurities.



IRONING ROOM AT BROOK HOSPITAL.
Showing the electrically-heated ironing apparatus.



INTERIOR OF A WARD, SHOWING HEATING ARRANGEMENT.

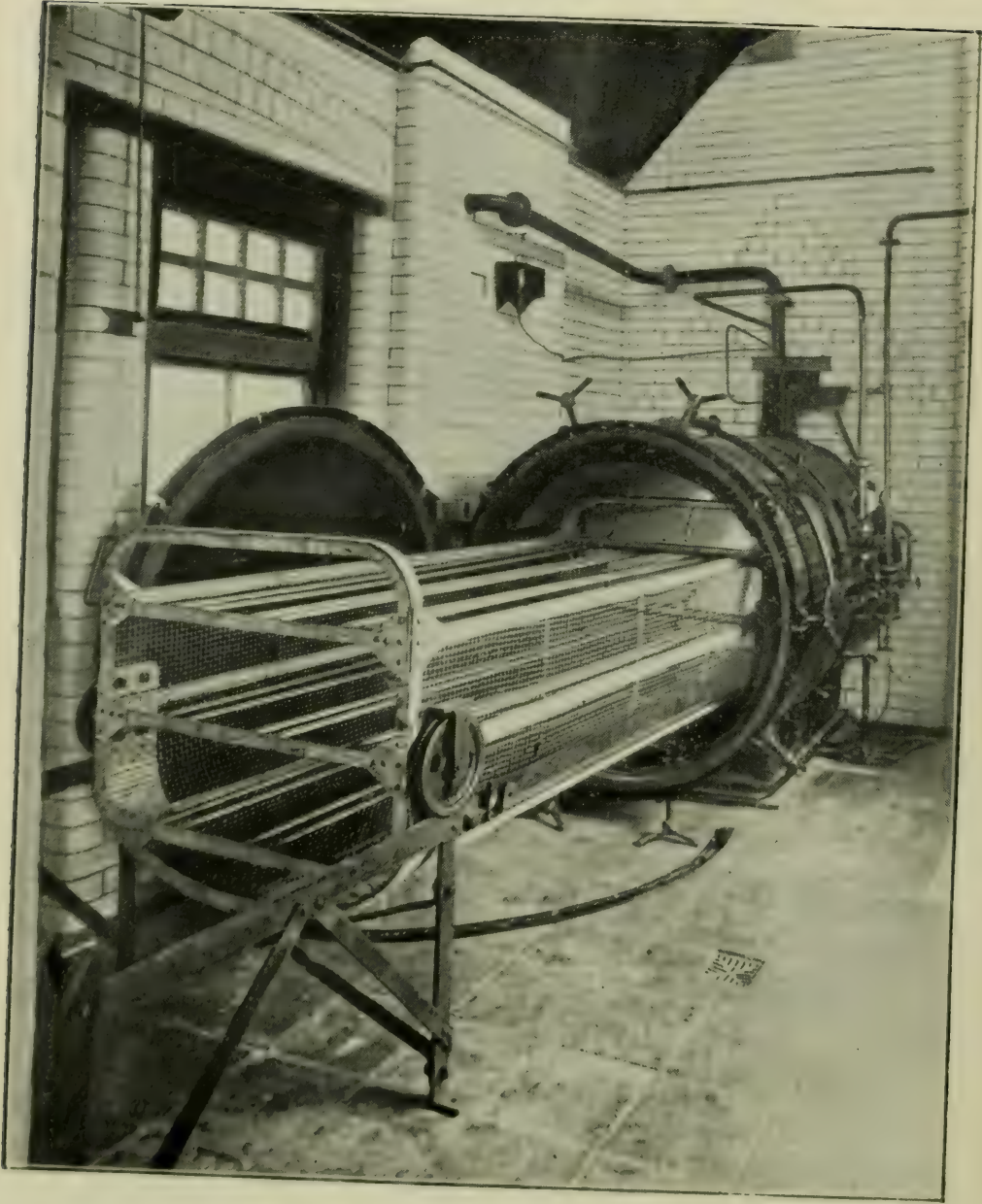
Taking for illustration one of the fever wards, the problem is not only to maintain the air at an equable and pleasant temperature, but also to warm the walls to a sufficient degree. If the air alone were heated to, say, 60° F., its heat would be imparted to the walls and windows, which, in cold weather, would probably be 12° and 18° (respectively) colder than the air.

The patients would, in such a case, suffer from the abstraction of animal heat, given out by radiation to walls at 48° F. and to windows at 41° F., notwithstanding the theoretically comfortable temperature of the air. By raising the air to 75° F. the walls might stand at 60° F., but the atmosphere would then be both oppressive and injurious. Bearing in mind the fact that the normal temperature of the human body is about 98° F., it will be seen that the reception of warmth is not required, and as an actual fact never takes place. The air and walls of a room do not impart heat, and they are warmed simply to prevent their stealing away from the body an undue proportion of heat. Radiant heat has practically no effect on air, although it warms solid objects which stand in the path of its rays. Such objects, when warmed, impart heat to air with which they are in contact, and it is important, therefore, that air entering a room for ventilation should pass over warm surfaces before being dispersed, and that it should be caused to circulate so as to be equally distributed. Arrangements also for warming the walls must on no account be omitted.



THE KITCHENS OF BROOK HOSPITAL.

Various systems, too numerous to mention, are adopted for the attainment of these ends. In the method applied at the Brook Hospital, fresh air is admitted to the wards through the radiators, and the radiators themselves are placed so that they may warm the air near the walls and windows, thus tending to prevent cold downward currents. In the centre of each ward are two handsome stoves with double fireplaces, the flues of which descend under the floor; the top and sides of the stoves are encased in Burmatoff faience. The object of this apparatus is to warm fresh air admitted through channels by contact and to warm the walls by direct radiation. The stoves also aid ventilation, and give a cheerful aspect to the room. Ventilation shafts extending above the top of each pavilion remove vitiated air, the draught being facilitated by internal coils of steam pipes. For the purpose of aiding ventilation in summer, hopper-hung fanlights, opening inwards, are fitted above the windows, and alternative connections are provided for each of the ventilation shafts. In considering the quantity of heat required for warming each ward, account has to be taken of the number of cubic feet of air necessary for each patient. In fever wards it is usual to allow 4,000 cubic feet per hour, and for twenty patients 80,000 cubic feet have, therefore, to be warmed to, say, 60° F. In winter the amount of heat absorbed in the attainment of this object would probably be represented by 40,000 or more heat units per hour.



A STEAM DISINFECTOR.

The mechanical equivalent of this is approximately 30,000,000 foot-pounds,—energy sufficient to raise 13,348 tons one foot.

Large as may appear the quantity of heat necessary for warming the air, it is considerably less than that passing through the windows and filtering through the solid walls as easily as water passes through a sieve. In severe weather the heat dissipated into space by the walls of a single ward probably equals 60,000 heat units per hour. Thus the grand total to be provided by radiators and fires is brought, in

round numbers, to 100,000 units per hour, which, expressed in foot-pounds, is 77,200,000 pounds, or 34,464 tons lifted one foot.

The heat necessary is conveyed in the form of steam by mains passing along subways under the covered paths shewn in the ground-plan. Under the entrance to each pavilion is a chamber containing a water-heater, where the latent heat of steam is given up to water contained in a cylinder, whence it circulates through the radiators and returns to be reheated by fresh accessions of latent heat. The steam, thus robbed of the power by which its molecules are held apart, condenses into water, and in turn is sent back to the central station, to be reconverted into steam. In addition to furnishing the means of heat for radiators, steam is used for the purpose of affording supplies of hot water to the bath rooms, ward kitchen, scullery, etc.

It is, of course, unnecessary to follow the arrangements for heating and ventilating throughout the hospital, as they are all based on a similar system. Speaking generally, both radiators and fires are used for wards, radiators alone for corridors, bath-rooms, etc., and coal fires for sitting rooms. The isolation wards, containing from one to four beds each, are provided with warming and ventilating apparatus, etc., similar to those in the main ward pavilions, except that steam is used for heating in place of hot water.

The quantity of coal burned for purposes other than the steam boilers varies considerably, according to the weather, but the average is probably from 10 to 15 tons per week.

Let us now turn to another most important application of heat, as realised in the form of light.

Closely adjoining the boiler house is the electric-light station, consisting of two rooms, in the first of which are three Belliss high-speed engines and three Siemens dynamos of 50 indicated horse power each. Here also are the switchboards and all necessary appliances for the regulation of the whole system. The second room is occupied entirely by a storage battery of 64 cells by the Electric Power Storage Co., the total capacity of which is 500 ampere-hours.

Every part of the hospital is fitted with electric lights, varying from the tiniest of incandescent lamps to arc lights, each of the latter representing energy equal to one horse power. The incandescent lamps are little short of 5,000 in number, and there are 18 arc lamps. The wires by which the electric current is conveyed from the central station to the hospital wards are carried in two distinct circuits, so as to permit repairs without interference with lighting arrangements.

As a means of light gas is very sparingly used, but pipes and a limited number of burners are fitted in the wards for use in the event of serious breakdown to the electric light.

Other purposes for which electricity is employed are the production of vapour in bronchitis kettles, the sterilisation of surgical instruments, and the establishment of a complete system of telephonic communication. There is a central exchange in the office of the superintendent nurse, communicating with the whole of the hospital buildings, with the adjacent ambulance station, and with the offices of the asylum board in London. A central fire-alarm gong is also situated near the centre of the buildings and connected to each separate block by electric wires. This gong is furnished with an indicator, showing from what point the alarm has been received, and with it are connected smaller gongs, sounding in some of the offices and in the men's quarters. The whole of the electrical plant is on a most complete and efficient scale, and was designed and erected under the supervision of Professor Kennedy.

Disinfection, or the destruction of the minute organisms which have been found to constitute the primary cause of all disease, is an operation indispensable in a fever hospital, and is most effectively performed by the aid of steam. The disinfecting chamber, situated at the rear of the boiler house, is divided into two rooms, one for infected, the other for disinfected, articles. Built into the dividing wall is the apparatus, which is that known as the Equifex, using "saturated" as distinguished from the "superheated" steam employed in other types of high-pressure disinfectors. It consists of a steel cylinder somewhat resembling a steam boiler fitted with doors at each end. For preventing loss of heat by radiation the apparatus is protected by non-conductive material and lagged with wood. The articles for treatment, consisting of wearing apparel, bed linen, or mattresses, are placed in a carriage which runs on rails into the apparatus. When the door is closed and securely fastened, air is removed by means of dry saturated steam, which is then caused to fill the machine at a pressure of 10 pounds per square inch. In this the objects remain for a period of about fifteen minutes, which suffices for complete sterilisation. During the process use is made of an exhaustor, which, by relieving the pressure, facilitates penetration of the articles, and at the same time re-evaporates moisture condensed and removes any particles of air retained by capillary attraction within the pores of the articles. Drying is effected by means of hot air, heated in its passage over steam pipes, and the articles are removed by the opposite door of the apparatus, once more ready for use. Connected with the machine is an instrument in which a pen actuated by steam pressure marks a diagram or a card attached to a drum rotated by clock-work. In this way the responsible officer may obtain a reliable record of the operations conducted daily, and he is thus in a position

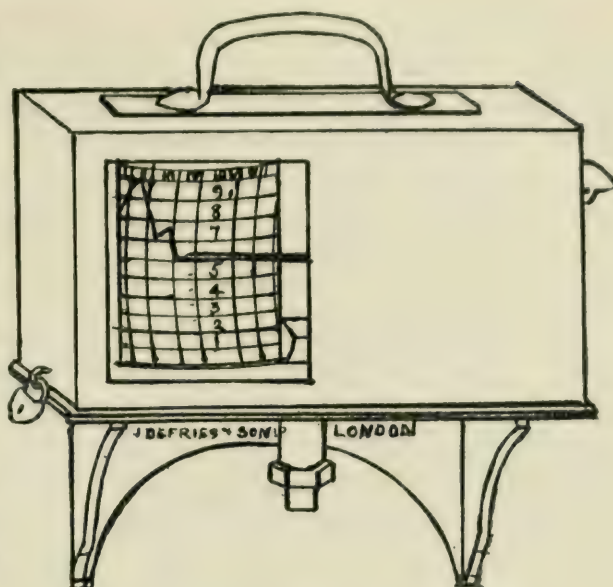
to know whether the proper conditions have been complied with in every case.

In some instances it is desirable to destroy infectious matter, or materials which are not of sufficient value for disinfection in the ordinary manner, and also to burn up refuse generally. For this purpose a furnace is usually provided, so fitted that the heat generated may be utilised for steam-raising

or for heating water. At the Brook Hospital there is such a furnace, answering the purposes of destruction, but it has not been thought necessary to make use of the heat produced by combustion, which escapes directly into the chimney shaft.

Immediately adjoining the boiler house is a 16-h.p. nominal, horizontal engine, by Davey Paxman & Co., with disc crank and box section girder frame. This is used chiefly for driving machinery in the laundries, where heat again plays an important part. All the power here used is but another example of the conversion of heat into work, and work again is transformed into heat, which is lost in outer space. Machines available both for cleansing and disinfecting under steam pressure are used in the laundries. Centrifugal power is made to contribute to the process of wringing, while heat is communicated to air by the aid of steam, and caused to traverse drying chambers by fans driven by steam power. Mangling, as ordinarily understood, is here abolished, this operation being effected by machines having steam-heated surfaces and rollers in which the largest articles are mangled or ironed without folds or creases.

Heat is led captive in the service of man in another direction, by assisting in the supply of water for the whole establishment. Adjoining the waterworks pumping station is a water tower standing about 90 feet high and containing a storage tank with a capacity of about 20,000 gallons. At the base of this is a pair of pumping engines, supplied by steam from the main boilers, and through them sometimes as much as 125,000 gallons of water are pumped daily. In lifting the 1,250,000 pounds of water, thus represented, to a height



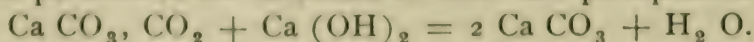
AUTOMATIC PRESSURE RECORDER.

of 90 feet, nearly 150,000 heat units are converted into work, and, when the liquid finally reaches the level from which it was raised, friction has restored, as heat, the whole energy expended. The interior of the tower is mainly occupied by a water-softening apparatus, capable of treating 60,000 gallons per day of ten hours. Chemical action, another equivalent of heat, is utilised for the purpose of depositing the lime salts whose presence in water is so objectionable and unnecessary.

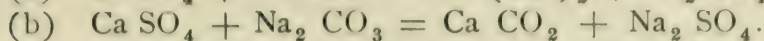
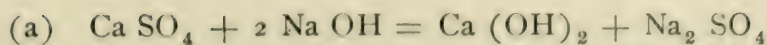
In the various processes of cooking heat plays a most essential part. Gas ovens and other forms of apparatus heated by gas are largely used in the spacious central kitchens of the hospital, and for many purposes its cleanliness and adaptability renders gas an extremely desirable means of obtaining heat. Steam is also employed in the cooking of meat and vegetables, and in the preparation of soups, broth, beef tea, etc. Steam-heated tables, with dished tops, are used for cutting up joints, and the lower portion of each carving table is enclosed by sliding iron doors, the interior being fitted with perforated shelves. A steam chest at the bottom furnishes heat, so that articles placed inside may be kept warm. The arrangements of the kitchens generally are admirably designed, and in a room close by are stored the dinner wagons, by the aid of which food is distributed to the various buildings.

The water mains are so arranged that water used for drain flushing, etc., is not softened, and all rain water from the roofs is collected in a circular tank, or pond, situated in the lower part of the grounds and capable of holding nearly 200,000 gallons. This water is pumped thence for use in the laundry and elsewhere.

The form of apparatus used is one in which the water is softened under pressure, thus facilitating the delivery of the water after treatment into the tank above. A small reagent pump for the lime is fitted to the main pumps, so that both work in unison. The incoming water passes over a small water-wheel actuating the lime-mixer, and deposition takes place on inclined plates. Carbonate of lime, the most common source of what is termed "temporary" hardness, is insoluble in water, save in the presence of carbonic acid, when the salt becomes an unstable bicarbonate. By adding lime in suitable proportion, carbonic acid is detached from the bicarbonate of lime, and both portions of the carbonate of lime are precipitated. Thus



For the elimination of "permanent" hardness, represented chiefly by sulphate of lime, it is necessary to add either caustic soda or carbonate of soda, according to the character of the water, and in properly-defined quantities. The equations are thus expressed :



In either case sulphate of soda remains in the water, but, being perfectly soluble, its presence is attended by no inconvenient consequences. For every reason the process is worthy of adoption, as tending to avoid the deposition of scale in steam boilers, to save soap, and to aid the various operations of cooking.

These, then, are the chief applications of heat in a public institution, such as we have been considering, and the whole forms one great example of the innumerable transformations of energy, which originally appearing in the form of the heat of the sun is stored in the fuel only to reappear in heat, light, electricity, and force in motion, even the buildings themselves representing the stored energy which was put into the materials when they were raised to form the structures.

As a concentrated illustration of all the varied forms in which heat may be applied, distributed and transformed, the institution which we have been describing is probably one of the most complete and in many ways not the least interesting.

FIRE-RESISTING CONSTRUCTION.—THE REGULATIONS IN FORCE IN LONDON.

By G. A. T. Middleton.

I.—GENERAL BUILDINGS.

PROBABLY no city in the world has so carefully devised a code of building regulations as has London, or so complete and efficient machinery for seeing that they are complied with. While many other points are dealt with, that of resistance to the spread of fire, if it should break out, and prevention of its occurrence so far as is possible by constructional means, has received a very large share of attention. Some of these regulations may be of purely local importance, and some even may be impossible of adoption in America, quite opposed to certain generally-received opinions ; but an enumeration of the most important cannot be without interest.

For instance, it would probably be thought intolerable that the height of a building should be restricted ; yet eighty feet, exclusive of two storeys in the roof and of ornamental towers or turrets, is the limit allowed without a special permit, which it is scarcely possible to obtain. Primarily this regulation was made for the sake of light and air to surrounding streets and buildings, but the limit was fixed also largely because a fire occurring in the upper storeys of a high building is excessively difficult to deal with. For this reason it is also provided that any storey constructed in the roof of any domestic building the upper surface of the floor of which storey is more than sixty feet above the street-level shall be of fire-resisting materials throughout, while in any building having a floor of that height there must be provided such means of escape, in case of fire, for the persons dwelling or employed therein as can be reasonably demanded under the circumstances. More than this, every building, such as a shop, which exceeds one thousand square feet in area, and is used partially for trade or manufacture and partially for residence, must have the portion used for residence entirely separated from the portion used for trade by fire-resisting floors, walls, passages, and stairs, except that any doors necessary for communication may be provided in the walls of the staircases and passages. Even more stringent still is the provision that in every building exceeding 2,500 feet in area and containing separate sets of chambers, or offices, or rooms constructed or adapted to be tenanted by different persons, the floors and principal staircases shall be of fire-resisting materials, this regulation affecting almost all erections in flats. Buildings more than 30 feet in

height, and used wholly or in part as dwellings or factories, must also have means of escape provided in the form of means of access to the roof (whence neighbouring roofs may be reached). Unfortunately this applies only to buildings with parapets, which are not compulsory.

The present building regulations—the London building act, 1894—having been devised largely for the express purpose of preventing the spread of fire, it is natural that all external walls, and those separating tenements in different ownerships (known as “party walls”), should be required to be of fire-resisting materials of specified thickness, varying according to an elaborately-laid-down table to correspond with their height and unsupported length. The only timber permitted in external walls is that required for bressummers and storey posts under same, and the frames of doors and windows of shops on the ground storey, unless they be set back four inches at least from the external face. This effectually precludes the use of the picturesque half-timber construction which is so great a favourite in the provinces. Certainly, power of exemption from this clause rests with the county council in the case of certain hard woods, but it is extremely difficult to obtain such exemption.

The complete separation of one building from another by a fire-proof party wall is very stringently insisted on. It is not permitted to build any bored timber or wood plate into such wall, whatever its thickness, and, if the ends of any wooden beam or joist bear upon it, they must stop $4\frac{1}{2}$ inches short of the centre; so that there is always a minimum thickness of 9 inches of brickwork or masonry behind any combustible material. If wood plates are needed, they must be carried on corbels.

In order to effect complete separation, these party walls have to be carried above all roofs, and to be corbelled out to separate all eaves gutters; in a building of the warehouse class they must be carried three feet above the roof, and in any other building at least fifteen inches. Where there are dormers or turrets within four feet of the party wall, this must still be carried up as a screen, almost as if they adjoined it. The result of this regulation has been that the party wall, where seen above the roof, as it necessarily must be, has become an architectural feature, the despair of the unskilful, and the opportunity of the skilful, architect.

Roofs, though they must be covered with some incombustible material, such as slate or tile, need not themselves be of fireproof construction. If they were, the necessity for carrying the party wall above them would disappear, and there would be no danger of the roof falling in, should a fire occur.

There are no less than twenty-two subdivisions of the section of

the building act dealing with chimneys and flues, providing carefully for safety, yet allowing all reasonable latitude. Chimneys are allowed, for instance, to be built on iron girders, if properly supported, or on corbels of any incombustible material, if they do not project from the wall more than the thickness of the wall directly below the corbel. If provided with proper soot doors of not less than forty square inches, the flues may be constructed at any angle; if without them, the angle must be not less than 45° with the horizon. All angles must be rounded. Soot doors must be kept at least fifteen inches from all woodwork.

In ordinary circumstances the brickwork of a flue need be only half a brick ($4\frac{1}{2}$ inches) thick; but, if it is to be used where considerable heat is to be expected, as for any furnace, or even a close fire used for purposes of trade, or for the cooking range of any hotel, tavern, or eating-house, the thickness must be at least $8\frac{1}{2}$ inches, from the floor on which this furnace may rest up to the ceiling of the room next above the same. Doubtless it has been difficult to define the line of demarcation, but it seems as if many boarding-houses, and even the larger private houses, often have as much heat generated in their kitchen ranges as is generated in hotels. A minimum thickness of $8\frac{1}{2}$ inches is also insisted upon at the back of a fireplace in a party wall (though only up to 12 inches above the mantel) and on the upper side of all flues inclined at less than 45° with the horizon.

The inside of every flue must be forged, or else lined with stoneware piping, as must also the outside where passing any floor or roof or behind or against any woodwork—a somewhat unnecessary rule where the flue passes through a fireproof floor, but generally a salutary one, in view of the great number of fires which have been traced to the igniting of woodwork near an overheated flue.

Incombustible hearths must be provided to all chimney openings, at least 6 inches wider on the longer side than the opening, and projecting 18 inches in front, carried entirely on incombustible supports. No timber or woodwork is permitted to be placed underneath the hearth within ten inches of its upper surface.

Similarly, no woodwork may be inserted in any wall or chimney breast within 12 inches of the inside of the flue or chimney opening.

Furnace chimney shafts are just as carefully regulated as are those for ordinary fires, but rather from the standpoint of stability than from that of fire prevention, as they are usually detached.

Pipes conveying smoke or other products of combustion must be fixed at least 9 inches from combustible materials; pipes conveying heated air or steam, at least 6 inches; pipes conveying hot water, at least 3 inches. This rule does not apply, however, if the hot water

or steam be at low pressure, this being defined as being provided with a free blow-off.

Wooden structures more than 12 feet in height are allowed to be erected only under special license, difficult to obtain; except hoardings enclosing vacant lands, and temporary structures erected by a builder for use during the construction or alteration of a building.

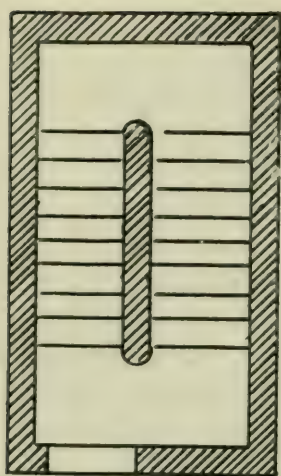
II.—PLACES OF ENTERTAINMENT.

If, however, the precautions against fire, in the case of ordinary dwellings, are stringent to the limit of expediency, much more so are they in the case of places of entertainment, in the interests of the large crowds which collect and whose lives would be jeopardised by a panic. It is the panic, in fact, caused by a fire alarm, rather than the occurrence of a fire itself, which is the most dreaded; consequently a great deal of attention is given in the regulations to the provision of adequate means of escape, and to localising any fire which may occur.

To obtain a perfectly open site in crowded London is exceedingly difficult, and large theatres in the heart of "town," and small suburban concert halls, have alike to be contented with something less ideal; but, as all classes of buildings devoted to entertainments are treated under the same regulations, all are required to have at least one half of the length of the boundaries of the site abutting upon public thoroughfares, the principal one of which must be at least 40 feet wide, and the others at least 30 feet wide, if carriage-ways, and 20 feet wide, if foot-ways. There must be at least two of these thoroughfares; for there must be at least two exits, not leading into the same thoroughfare or way, to every tier or floor of the premises; and, if any tier or floor is divided into two parts, then each part must have its two separate exits, and these exits must be so arranged as to offer a ready means of egress from both sides of each tier or floor direct to the outer thoroughfare. Were this provision an absolutely rigid one, however, it would do away entirely with the vestibule, or *foyer*, so general and beautiful a feature in all large theatre plans; so this is permitted as one of these means of egress. But only three tiers, or floors, at most, may communicate therewith, and its width must be one third greater than the combined width of all the doorways opening into it, which operates not so much to the increasing of the width of the vestibule as to the cramping of that of the doorways.

While two exits must be provided from each tier or floor, however, only one of these may also be used as an entrance.

With this careful provision as to number of exits, it becomes of the first importance that their size and construction should also be regulated. Consequently, every staircase, lobby, or passage for use



TYPICAL STAIRWAY.

of not more than 400 persons must be 4 feet 6 inches wide, this being increased by 6 inches for every additional 100 persons, until a maximum width of 9 feet is reached. The stairs must be of solid square steps, with at least 11-inch treads and at most 6-inch rises, in straight flights of not less than 3 and not more than 12 steps each, with treads of uniform width and the ends of steps pinned into brick walls at both ends. No staircase may have more than two flights of 12 steps each without a turn, and the several flights must all be supported and enclosed upon all sides by brick walls at least 9 inches thick, carried up from the foundations, while all landings must be

at least 6 inches thick and square on plan. Thus the open staircase is an impossibility, the box form being so clearly suggested as to be in almost universal use,—the stairs, that is, being enclosed within a brick rectangle on plan, with a brick partition wall longitudinally down the middle, to separate and give support to the different flights. There must be a fireproof roof to the stairs, so that, once on the staircase, the people are safe; the short straight flights serve to break a rush, and reduce the danger from falling and crushing to a minimum.

The same fire-resisting character is required, so far as possible, in the whole building. Dressing-rooms must be of fire-resisting materials, in a block separated from the main buildings by party walls, with only the least possible of openings for communication, and provided with a separate exit; and, where there is a stage with proscenium, the proscenium wall must be of brick, at least 13 inches thick, and have only three small openings besides the proscenium opening, each closed with an iron door, so hung as to close of itself without a spring. All decorations round the proscenium must be of fire-resisting material, and the opening must be fitted with a fire resisting screen to be used as a drop curtain.

All workshops and painting-rooms, like the dressing-rooms, must be distinct, and of fireproof construction, all communication with the main building being through self-closing iron doors; and, of course, all limelight tanks and engine and boiler rooms must be similarly treated, as must all scene docks and stores.

All constructional ironwork throughout must be cased in fire-resisting material.

When gas is used as the illuminant, as is still usual, three separate meters and services must be provided,—for stage, auditorium, and stairways respectively,—the meters being placed in ventilated fire-

proof chambers. The piping must be of brass or iron, the brackets without joints, and, when within reach of the audience, secret taps must be used, to prevent the lights being turned out for mischief.

Upon the stage the regulations are equally complete, for protection of footlights, wing lights, battens, and movable lights, so that no inflammable dresses or scenery may reach them ; but strong flexible tubing is permitted of necessity to the movable lights.

For reasons difficult to explain much more fear is shown of electric lighting than of gas, and it is permitted only on condition that it is certified to be in good order, by a competent electrical engineer, every six months,—a great deterrent in the case of small suburban concert rooms, and generally thought to be unnecessary and vexatious.

Again, as with gas, three circuits must be provided ; but in this case, though the stage is separately served, the auditorium and stairways must have half their lights on one circuit and half on another, so as to remain lit even if one circuit be cut off. No sub-circuit may carry more than 65 ampères, and each sub-circuit must start from a distributing board.

Conductors conveying currents of high electro-motive force inside buildings must be specially insulated and cased in a fireproof casing, with terminals at least 12 inches apart and carefully protected from risk of contact.

Generally speaking, the regulations affecting conductors, switches, and cut-outs are very closely detailed, with a view to preventing all possibility of dangerous short-circuiting, or spark, or the falling of fused metal ; while arc lamps are practically prohibited, and generating plant has to be kept distinct, the sufficient ventilation of any room containing a gas engine being particularly insisted upon, as is also the ventilation of all rooms containing primary or secondary batteries.

In addition to gas or electric lighting, a few oil or candle lamps have to be kept continuously burning, but mineral oil may not be used.

As protection in the event of a fire, all places of entertainment calculated to accommodate one thousand persons or more have to be provided with fire hydrants supplied either from a water main or from two large cisterns, each containing at least 250 gallons of water per hundred persons of the audience ; while theatres are obliged to have direct telephonic communication with the nearest fire brigade station,—a notable thing in London, where the telephone is very little used.

THE HIGH-SPEED STEAM YACHT AS A FACTOR IN TORPEDO-BOAT DESIGN.

By W. P. Stephens.

II.

THE year following the Stiletto's advent, her builders sent to New York, on the occasion of the annual regatta in June, another notable craft, the open launch, Henrietta. She was 48 feet over all, 46 feet 7 inches lwl, 7 feet 6 inches beam, and 3 feet draft, with a triple-expansion engine 4 and 6½ and 10 inches by 8 inches. She too showed a very high speed in her ordinary running about New York, and made a record a little later in the American Yacht Club regatta, when she covered the Larchmont-New London course in 5 hours, 22 minutes, and 14 seconds, being second to Atalanta out of a fleet of steam yachts very much larger than herself.

The owner of the Henrietta, to whose order she was built, was the late Norman L. Munro, of New York, an enthusiast in the development of the high-speed steam yacht. He had already built the Norma, a large-decked steam yacht, from which much was expected, but which proved a failure. The success of the Henrietta led to the placing of an order with the Herreshoffs for a larger craft, and in 1887 the Now Then was launched at Bristol. She was of the regular wooden construction of the firm, 86 feet 4 inches over all, 81 feet 9 inches lwl, 10 feet beam, 5 feet 7 inches depth of hold, and 3 feet 2 inches draft, with triple-expansion engines 7½, 12, and 19 inches by 10½ inches, and a coil boiler 6 feet 3 inches by 5 feet 3 inches. Though a fast boat, the Now Then by no means came up to the standard of the Stiletto and Henrietta, and failed to meet the expectations of her owner. The following year she was returned to her builders in partial payment for a new and still larger yacht, from which a much higher speed was expected. The Say When, as she was named by Mr. Munro, was 138 feet over all, 115 feet lwl, 14 feet beam, and 4 feet 6 inches draft,—an elaborately-built craft, with mahogany planking and a complete outfit of the most improved Herreshoff machinery. The Now Then was of the decked launch type, with the stern cut away on deck and broadening out just at the surface of the water, but the Say When was of the conventional steam-yacht type, with longer clipper stem and the usual yacht counter. Though a serviceable boat, she too failed to realize the speed expected of her.

The building, in successive years, of the Stiletto, Henrietta, Now Then, and Say When served to attract the attention of yachtsmen



THE "NOW THEN," DESIGNED AND BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.

and the general public to this type of yacht, and to awaken a very deep interest in it. While the *Now Then* was under construction, rumors were current of a new craft, the work of an unknown designer, that might be expected to take a high place in the class. During the summer of 1887 these rumors took definite form in the advent in eastern waters of the *Buzz*. This yacht, both hull and machinery, was designed and largely built by Mr. C. D. Mosher, of Amesbury, Mass., a young man who for some time had been engaged in the



THE "SAY WHEN," DESIGNED AND BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.



THE BUZZ, DESIGNED AND BUILT BY C. D. MOSHER, NEW YORK.

study of the problem of high speed by methods of his own, making numerous experiments with models, launches, boilers, and engines. The result of a great deal of study and preparatory experiment was a cabin launch 50 feet over all, with a ram bow, 6 feet 6 inches beam, 3 feet depth of hold, and 1 foot 4 inches draft aft. The hull was of light construction, with oak frames 1 by 1½ inches, spaced 8 inches. The displacement was 3.50 tons. The double-cylinder engines were 8 by 8 inches, with steel bar frame, the piston valves being 3 inches in diameter. The locomotive boiler was of the torpedo-boat type, 5 feet long and 2 feet 8 inches in diameter, with 250 brass tubes, the heating surface being 357 square feet. A Sturtevant blower, connected to the main shaft, discharged into a closed ashpit. The Buzz was speeded over short courses a great many times, in the east, on the Merrimac river and about Boston, and also on Long Island sound, covering the measured mile in 2 minutes 30 seconds, her highest record being 2 minutes 8 seconds. She was finally sold to Messrs. McBride, of Philadelphia, who used her on the Delaware river, under the new name of Yankee Doodle. In 1891 she was burned while at anchor; the hull sank, but was raised later, and the machinery was used in a new and larger hull, Yankee Doodle II. As a result of the success of the Buzz, Mr. Munro placed an order with Mr. Mosher for a larger boat, the hull of which was built by W. K. Pryor, of South Boston, while the engines were built directly under the designer's supervision. This new craft, the Norwood, was not completed until 1890, making her appearance in New York in mid-summer. She was 63 feet over all, 7 feet 3 inches beam, and 4 feet extreme draft, with open cockpits forward and abaft the engine space, each 10 feet long. She was decked forward for a length of 12 feet and aft for a length of

10 feet, with water-tight compartments under the decks. Her triple-expansion engine had cylinders 9, 14½, and 22 inches by 9 inches, indicating 450 h. p. when making about 560 turns. There were independent air and feed pumps, blower engine, and an inboard surface condenser. The boiler was of the modern water-tube type, designed by Mr. Mosher, with 800 square feet of heating surface, the working pressure being 275 pounds. The *Norwood* marked a distinct advance, in design and construction, over previous efforts, departing widely from the old type of launch hull, and indicating the new line on which advances have been made. Above water she



THE VAMOOSE IN THE HERRESHOFF SHOPS, BRISTOL, R. I.

The bow of the *Penguin* is seen in the foreground.

showed a plumb stem and straight sheer, with sides nearly vertical, all the level lines, from deck to water, being round and full, with the greatest breadth well aft and carried out with little diminution to the extreme stern. The floor was nearly flat, and carried well fore and aft, with a short round to meet the sides. At its after end, over the propeller, it was concave, similar in shape to the bowl of a spoon, the edges of this spoonlike portion joining the sides at a sharp angle. The construction included a system of light steel channel beams as keelsons, steel frames, and mahogany planking in two skins, ¾-inch inside and ⅝ inch outside, with canvas between. In her many runs about New York, the *Norwood* has shown a speed of more than 30 miles.

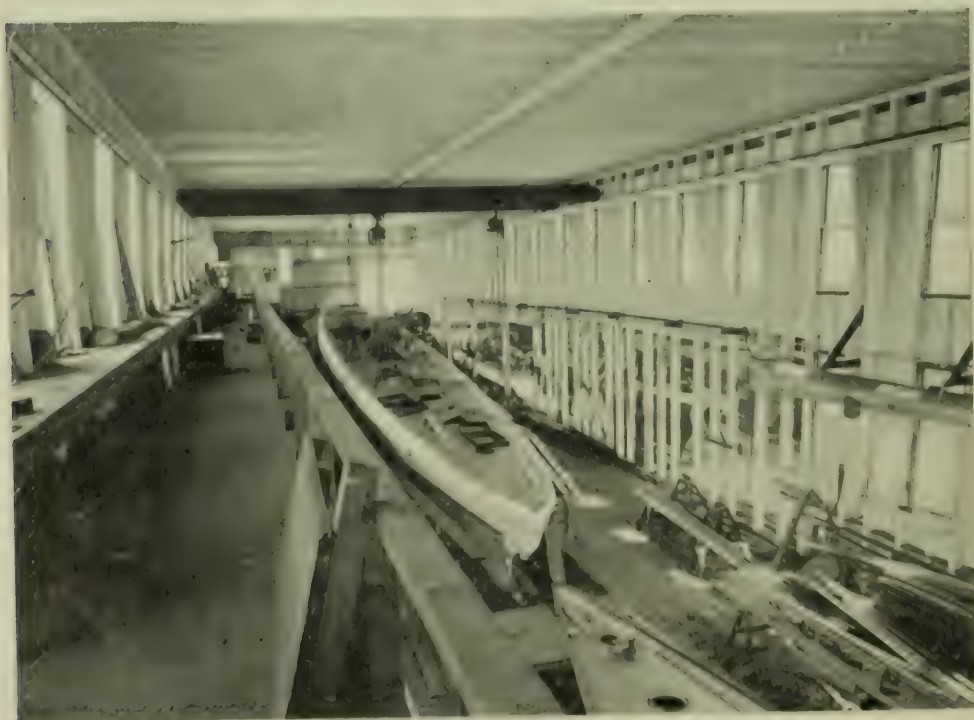
In 1890 the Herreshoff Manufacturing Co. completed the second



U. S. TORPEDO BOAT CUSHING. HERRESHOFF MFG. CO., BRISTOL, R. I.

torpedo boat built for the United States government, the Cushing, built of galvanized steel, 137 feet 6 inches over all, and of the general type then built in large numbers by the British and continental governments. The Herreshoff type of coil boiler was discarded for the Thornycroft type of water-tube boiler, and quadruple-expansion engines were used.

In the summer of 1891 two steam yachts were launched at the Herreshoff works, the Javelin and the Vamoose. Both were of the



THE VAMOOSE IN THE HERRESHOFF SHOPS, BRISTOL, R. I.



THE VAMOOSE, DESIGNED AND BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.

full-decked type, with accommodations for cruising, but they were intended for a far higher speed than had thus far been attained in this type of craft. The *Javelin*, ordered by Mr. E. D. Morgan, was 97 feet 10 inches over all, 94 feet 6 inches lwl, 10 feet 3 inches beam, 6 feet 7 inches depth of hold, and 5 feet draft, with triple-expansion engines 9, 14, and $22\frac{1}{2}$ inches by 12 inches, and a Thornycroft boiler. The *Vamoose*, ordered by W. R. Hearst, of San Francisco, was 112 feet over all, 108 feet lwl, 12 feet 4 inches beam, 9 feet 6 inches depth of hold, and 5 feet draft, with quadruple-expansion engines, one cylinder $11\frac{1}{4}$ inches, one 16 inches, and three $22\frac{1}{2}$ inches by 15 inches stroke. With 400 turns the i. h. p. was 800. The two yachts were of similar model and construction, with a rounder section and more deadrise than the *Norwood*, and the after body fined away in the usual manner. The *Javelin* failed to realize the expectations of her owner, and did not show remarkable speed. The *Vamoose* was more successful. She has been in continual service for a number of years, and has a record of 22.6 miles, over the American Yacht Club course off Milton Point.

The first reputation of the Herreshoffs as builders of fast yachts was made in sailing craft, prior to the seventies. For nearly twenty years, however, their main efforts were directed to the improvement of the steam yacht, other designers meanwhile becoming prominent in the sailing division. At the same time that the *Javelin* and the *Vamoose* were being built, the firm had on the stocks a sailing yacht to the order of Mr. E. D. Morgan for the then new 46-foot class. Of the many fast vessels associated with the name of Herreshoff, there is



THE FEISEEN, DESIGNED BY C. D. MOSHER, NEW YORK.

none, perhaps, more famous than this craft, *Gloriana*. She was remarkable not only for her superiority to all others of her class, but as the embodiment of certain new principles of designing which since have been universally accepted by designers. Her wonderful success turned the work of the Bristol shops into a new channel. She was followed by a still greater novelty, the fin-keel *Dilemma*, in the fall of 1891, by *Wasp* in 1892, *Navahoe* and *Vigilant* in 1893, *Defender* in 1895, and a fleet of smaller craft that have been successful abroad as well as in home waters. With the building of the *Cushing* and *Gloriana* the work of the Herreshoffs took a new direction. While still building steam yachts of the cruising type, they have made no attempt at exceptionally-high-speed yachts since the *Vamoose*, their efforts being concentrated on sailing yachts and on torpedo boats.

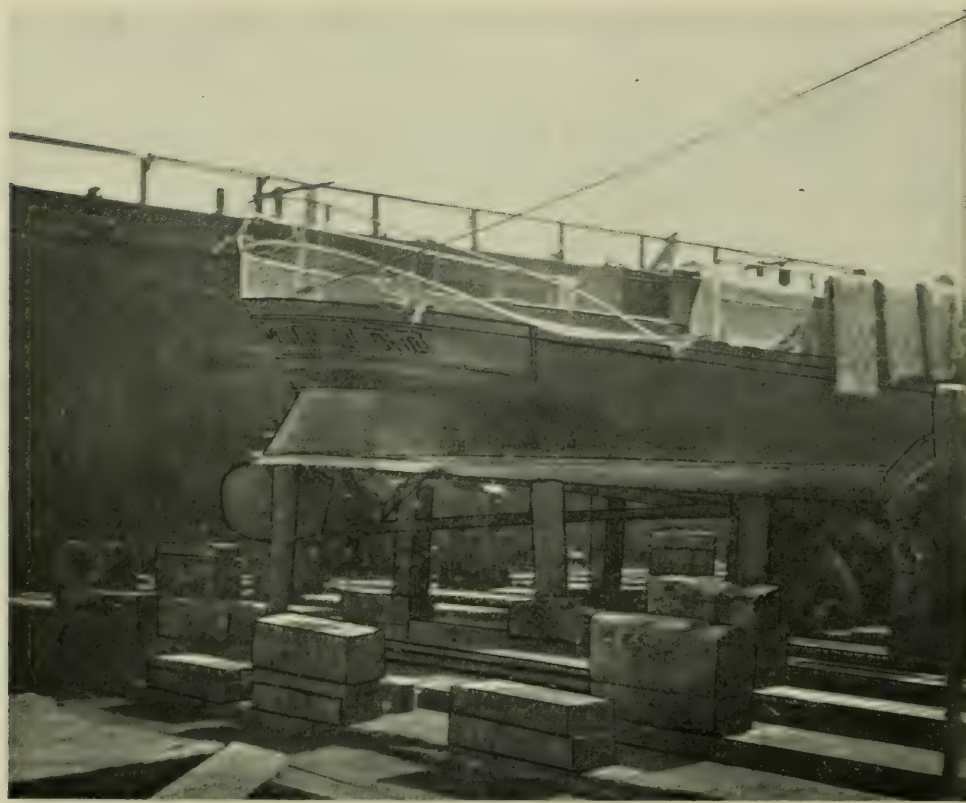
After the success of the *Norwood*, Mr. Mosher came to New York and designed two larger yachts, the *Feiseen* and the *Nada*, which were built by Wood & Son, at City Island, New York, in 1893. The *Feiseen*, built for W. B. Cogswell, of Syracuse, N. Y., was 85 feet over all and the same on the waterline, with 9 feet 8 inches beam and 3 feet 6 inches draft, with engines 9½, 13½, 18, and 24 inches by 10 inches, developing 600 i. h. p. when making 600 turns, the Mosher boiler working at 250 pounds. The *Nada*, built for Mr. Hugh J. Baxter, was 85 feet 9 inches long, 11 feet 6 inches beam, and 3 feet 4 inches draft, with cylinders 10, 14, and 20 inches by 10 inches. The two were similar in construction to the *Norwood*, double-skin composite, and both were of the decked cruising type, but intended for different purposes. The *Feiseen* was expected to realize an exceptionally high speed, as an experimental craft. The

Nada was intended for the regular service of her owner, carrying him to and from the city at a higher speed than was attained by other yachts in the same service on the Sound and the Hudson river. Both proved successful, the Feiseen making at times more than 31 miles. They boasted of comfortable cabins, galley, and the usual accommodations of a cruising yacht, the Nada, in particular, being very elaborately fitted below. At the time of the troubles in Brazil, 1893, both the Feiseen and the Javelin were sold to that country, being refitted as torpedo boats in New York, with conning towers and armament, and shipped to Rio Janeiro by steamer.

The highest speed thus far attained by a steam vessel was achieved in the last effort of Mr. Mosher, the steam yacht Ellide, built at Nyack, by Samuel Ayers, for E. Burgess Warren, of Philadelphia, and launched in April, 1897. The Ellide is of the open cockpit type, designed exclusively for high-speed experiment. She is 80 feet over all and on the waterline, 8 feet 4 inches beam, and 3 feet 6 inches draft. From the knife-edge of her bronze cutwater her sides swell out in a slightly convex wedge, with beautifully-curved lines until the midship section is reached, the sides from there aft being practically parallel and vertical. The bottom is nearly flat amidships, with a short round joining it to the sides, the sections assuming more of a deep U shape as they near the bow. The after portion of the bottom, forward of and over the wheel, is of the spoon shape already mentioned. The stern is of a peculiar form, best described perhaps by the simile of one half of an hour-glass divided by a vertical plane through its longitudinal axis. The outline on deck is a semi-circle, as is that around the spoon portion of the bottom, the sides between deck and bottom being constricted, like the neck of the glass. The hull is of composite construction,—a very light frame of steel keel-



THE NADA, DESIGNED BY C. D. MOSHER, NEW YORK.



THE FEISEEN; DESIGNED BY C. D. MOSHER, NEW YORK.

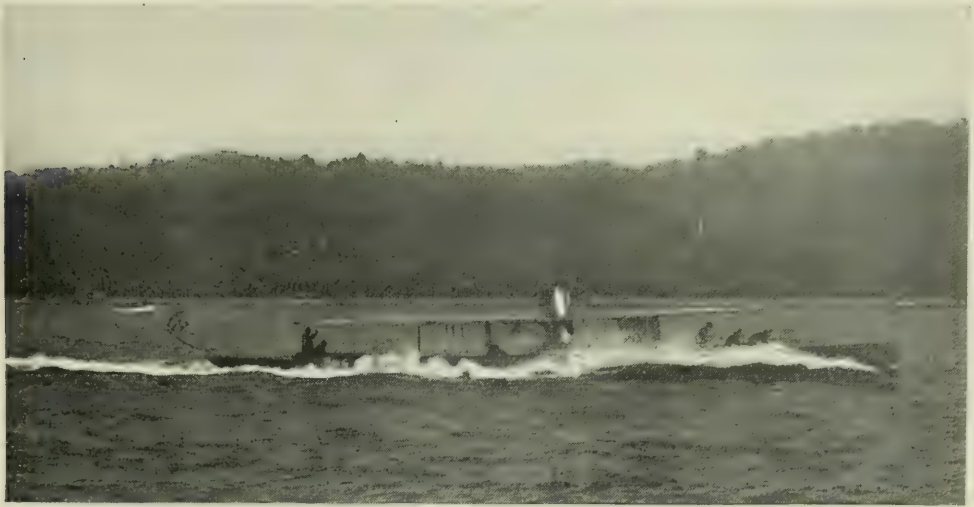
View in dry dock, showing typical stern and middle body of the Mosher type.

sons and ribs strongly braced, with a double skin of mahogany fastened with bronze bolts. The engines were specially designed by Mr. Mosher and constructed under his supervision; the cylinders are 9, 13, 18, and 24 inches by 10 inches. The boiler is 6 by 8 by 4 feet 6 inches, with 1,228 tubes of solid-drawn steel. Six independent engines are employed for the circulating pump, feed pumps, blower, etc. The speed trials were made last summer under such conditions as to secure absolute and reliable results, a course of one mile being laid off by officers of the United States coast survey, and the trials being witnessed by officers of the navy. The yacht made a speed of 37.89 miles, covering the mile in 1 minute 35 seconds.

The purpose of such craft as the Stiletto, Norwood, Feiseen, and Ellide is almost entirely experimental, to pave the way for improvements more directly utilitarian. It is not to be expected that the speed attained will be equalled for some time to come in vessels of greater size and of different type. The highest results thus far in the large sea going cruiser type have been attained by the Fairfield Shipbuilding and Engineering Co., of Glasgow, in the steam yacht Giralda, recently sold to the Spanish government for conversion to war

purposes. This yacht, designed by her builders, was launched in 1894; she is 312 feet over all, 275 feet lwl, 35 feet 1½ inches beam, 19 feet depth of hold, and 1,664 tons, Thames measurement. As a pleasure yacht, she is elegantly fitted throughout, nothing being sacrificed in this respect. Her power includes two sets of triple-expansion engines, each with one 25 inch cylinder, one 40-inch, and two 45-inch, by 27 inches stroke, driving twin screws. In a race at Nice, on April 11, 1895, the *Giralda* covered a course of 26.5 miles in 1 hour, 8 minutes, and 22 seconds,—a speed of 23.25 knots.

In this brief summary of the parallel development of the yacht and the war vessel, only the more typical craft have been mentioned, and no attempt has been made to do full justice to all who have taken part



THE ELLIDE; DESIGNED BY C. D. MOSHER, NEW YORK.
Photographed when making 37.89 miles an hour.

in the work. The outline of the subject is, however, sufficiently complete to demonstrate several important points. With the successful experiment of the *Miranda*, in 1871, the British designers practically abandoned the high-speed yacht as an intermediate, and took up directly the problem of the torpedo boat, and in 1885 the torpedo-boat destroyer. The liberal support accorded by the British government and the continental powers made it possible for Messrs. Yarrow, Thornycroft, Normand, and others to carry out elaborate and costly experiments year after year. These favorable conditions not only made it unnecessary to experiment through the steam yacht, but, by concentrating all efforts on the torpedo boat, tended to hinder the other line of yacht development. The requirements of British yachtsmen have been, in the main, seaworthiness and accommodation rather than speed, and, with the attainment in the steam fleet of a high degree of perfection in the first two, there has been little de-

mand for more than a good cruising speed, maintained regularly in continued service. While the *Giralda* is an exceptional vessel, the past three years have witnessed a material increase in the speed of the larger yachts, as in the Watson craft,—*Mayflower*, *Varuna*, *Margarita*, and *Nahma*.

The great fleets of torpedo vessels in the navy lists of all European powers to-day, and the prominence accorded to this division in the naval estimates, show that there is ample inducement to the designers and builders to continue the work of improvement in the direct line which has produced such results. The condition of affairs in the United States has been in the past, and must continue to be, materially different. Though in a measure committed to the work of developing torpedo warfare in all of its branches, the United States did nothing after the civil war, and has consistently held to the same policy almost to the present day. That any progress has been made, and that the nation to-day is not entirely dependent upon foreign designers and builders, is due solely to a small number of yachtsmen who have furnished the material aid, and those American designers who have furnished the brains for experiment. The past four months have witnessed an awakening that is likely to be permanent; face to face with war, the whole nation has been forced to realize the vital importance of a strong defensive navy, and the danger to which it has been long exposed by the policy of a wasteful economy. There is little doubt that, as soon as the present war is happily ended, the work of naval construction will be taken up as never before. At the same time there is much to do, in every class, from the battleship to the smallest torpedo scout, and the experience of the past shows that a portion of this work can be better done by private enterprise than by government aid alone. The problem of extreme high speed, the precursor to a general increase of practicable working speed in all classes of vessels, requires for its successful solution the highest efforts of the designer, untrammelled by those limitations and restrictions which are almost inevitable when he is called on to deal with government bureaus.

THE GOLD RESOURCES OF INDIA.

By William King and Theo. W. Hughes Hughes.

INDIA has for centuries been so looked to as a land of potentialities in mineral development that few more difficult, or even thankless, tasks have fallen to the lot of those officially connected with its geological examination than that of having to qualify, if not dispute altogether, the so frequently exaggerated accounts of renewed prospecting in regions well known as barren, or of reported rich discoveries in tracts supposed to be new ; though there is, no doubt, room enough yet for the prospector, be he honest and capable, or the assumed and assertive practical adventurer, to explore the country lying between the more restricted and widely-separated regions of known geological formations of mineral value in the million and a half square miles of the empire.

It is no easy matter, either, to reconcile the aspirations of those interested in its material welfare to the seemingly poor and really scattered distribution of these formations. It seems a hard thing that all South India can as yet look to only one corner coal field, with its stores of magnificent iron ore beyond payable reach of fuel, whereas Bengal and the central provinces have the Indian carboniferous stores lavishly distributed ; and it is incomprehensible to most people that the Punjab oil flows should be so much poorer than those of Burma, and that a fancied resemblance between the two countries should not warrant favourable comparison with the Baku wells on the Caspian ; while perhaps no problem is oftener questioned than why gold should be so fitfully developed through the belts of the Indian metalliferous series occurring in the Madras presidency, the central provinces, Bengal, or Burma.

So it is, however, in the matter of distribution and extent, while the remarkable feature in the progress of these explorations in India is that there have been no particularly new discoveries outside the various tracts known for a very long time. It is the localization of them, their extent, and more particularly their development, which have been the work of geologists and mining experts for the last forty years. And this has been perhaps most strikingly shown in the very successful opening of the Mysore auriferous tract during the last seventeen years.

The auriferous character of this place and of all the other known places in India was founded on the occurrence of desultory, but apparently remunerative, washings of but small account, or upon mani-

festly ancient underground workings having distinct evidences, on the surface, of crushing and other manipulation of the ore matrix, where also washing was still carried on in the adjacent shallow streams or in the material from the old dumps. In no case, however, was there any knowledge or tradition of the old miners; nor was much known of the ore lodes, until geological surveying was instituted, when these various tracts were catalogued into ten districts of the Bengal presidency, three districts of Bombay, thirteen districts and smaller divisions of the central provinces, seven Madras districts, ten districts and divisions of the Punjab, in the eastern Godavari part of the nizam's dominions, in the north-west provinces, in Assam and Burma, and away north-westward into Afghanistan.

It may be said at once, of the gold-washing in all this wide distribution of more or less auriferous surface-material on or adjacent to presumably gold-bearing rocks, that it has never been found to pay any better than the desultory operations of the few washers who generally assemble or camp out at the recognized washing sites during the off-work seasons of the year. Several attempts at larger operations have been made by Europeans, particularly in Assam, but always without corresponding out-turn; and the only conclusion seems to be that those washing sites which appear the most promising are merely concentrations from tributary tracts only sparsely seamed by auriferous reefs, some of which may be found to repay quicker and larger concentration than that resulting from ordinary atmospheric denudation. In many cases of washing near the sites of old mining operations it is really the *dibris* from those mines, rather than the denuded materials of the reefs themselves, which are sifted by the washers.

On the other hand, the manifest inference from the ancient underground workings, looking at their extent and ramifications among quartz reefs and their leaders, is that here at least had been some more organized and continuous system of working, which gave a required out-turn, even though they were in all probability carried on under forced labour,—an inference which has been fully justified in Mysore. Thus it seems tolerably certain that the gold production of India is almost entirely dependent on the extraction of the metal from its original condition of lode-association rather than on any secondary or derived form of concentration.

Taking this view, the auriferous areas can be more definitely studied in peninsular India,—that is, all the country south of the great plain-belt of the Indo Gangetic alluvium. Outside this, or northward, is the extra-peninsular region, in which, with the exception of Burma, gold appears to be poorly distributed. In peninsular India the gold areas are generally embraced within the range of the transition series,

a few only, among them that of Wainad, being in the more prevailing Crystalline, or, generally, Gneissic, series. The more important indications are in a well-recognised development of the transitions originally distinguished in the district of Dharwar, in the Bombay presidency, as the Dharwar Series, by our colleague, Mr. R. Bruce Foote, and consequently shown by him to be the auriferous series of India *par excellence*. The gold fields of lesser note, or of as yet doubtful character, occur in belts of sub-metamorphic rocks, which certainly seem to be also of the Dharwar series.

Leaving the Wainad country for separate consideration, the main fields of the Dharwars are the Mysore and Dharwar belts in South India, the Raichoor Doabs tract in Hyderabad (Deccan), several belts in the central provinces area, and others in the Bengal tract in Chota-Nagpore. Ancient workings are more or less recognisable in all; and, seeing the marvellous success of the Mysore development only after very persevering and prolonged exploration, the poorest looking among the others should not be rashly condemned until fully tested. Nor ought the similarly-altered or sub-metamorphic and metalliferous rocks constituting the Aravali hill-ranges in Rajputanana and central India to be left unexplored.

So far, however, the true quality of the recognised Dharwar tracts has been completely proven only in the Mysore area, usually called the Kolar Gold Field; while the next northerly field in the Raichoor Doab is still on its trial, explorations having only just been followed by regular mine openings.

The Kolar Field lies in the Mysore upland (the old Balaghat of South India, in contradistinction to the Payen Ghat or plains), at an elevation of about 2,000 feet above sea-level, about 150 miles due west of Madras, in a long synclinal fold of quartzites and schists with trap intrusions, among all of which run auriferous lodes of various width and value and extending to great depths. This belt averages about four miles in width, extending for a distance of fully forty miles north and south. There were several old mines of considerable extent, especially in the neighbourhood of Ooregaum, Kembli, and Saranpali, which had been excavated in what appeared to be true reef veins of quartz, though subsequent workings and petrological considerations show that some of the ore-bearing rock is not reef quartz, but highly-folded and interbedded quartz-rock, somewhat like that of the Transvaal ore beds. It was in some of these old excavations that Mr. Lavelle, practically the first pioneer for Mysore, carried on his perseveringly laborious explorations (however unfitted he may have been for such work either by education or training), the ultimate successful result of which he happily and contentedly lived to see realised.

Decidedly favourable shows of gold were obtained from his washings, and most encouraging specimens of more or less glassy dark-blueish quartz, with clearly visible pure gold, were easily obtained from the old pits and from thin two-foot lodes cropping out at the surface.

This was in the seventies; ere long, in conjunction with several influential men, sufficiently favourable results were obtained to justify the asking and obtaining of a mining grant from the government of Mysore, over some ten square miles of the Ooregaum part of the Kolar district. After this, the usual company construction, mining ventures, and explorations prevailed with varying success, which, however, kept slowly diminishing, on the whole, until but one of the original companies remained, and that one undecided whether to shut down or make one effort more. Such was the condition of affairs in 1879-80; and not only had the Kolar concession failed to all appearance, but this was the case also with Wainad, in the Malabar district, on the western side of the Madras presidency, where one of us had formed a very favourable opinion from the good show of true reefs and old workings. Thus the verdict seemed to be imminent that what had seemed to pay the old workers was not sufficiently remunerative for modern methods. Fortunately, courage and pluck did not fail, and the Mysore Gold Company held on until stone was encountered, assaying the average return anticipated and with a promising reef extension; and so, since 1886, there has been a steadily-increasing production.

THE MYSORE MINE.

Total returns from the commencement to date.

DATE.	Tons of quartz crushed.	Tons of tailings treated.	Oz. bar gold from quartz and tailings.	Ounces Standard Gold.	Amount Realised.		
					£	s.	d.
Year ending—							
September, '84..	454	....	454	446.414	1,732	9	7
“ ‘85..	1,616	....	3,754	3,776.335	14,675	4	5
“ ‘86..	6,077	....	15,776	15,939.905	61,953	0	10
December, '87..	14,061	737	16,280	16,312.263	63,400	12	6
(15 months)							
“ ‘88..	20,191	4,319	19,090	18,868.859	73,349	13	1
“ ‘89..	32,567	13,227	49,234	49,749.011	193,535	9	7
“ ‘90..	38,812	18,535	58,181	59,082.313	229,966	16	4
“ ‘91..	40,353	20,821	66,499	67,112.332	261,485	0	8
“ ‘92..	44,548	38,727	64,391	64,004.279	249,331	15	1
“ ‘93..	49,822	50,249	65,409	65,345.798	254,311	9	8
“ ‘94..	60,957	54,511	52,273	52,249.578	203,087	6	2
“ ‘95..	60,654	56,662	69,487	69,728.960	270,911	0	8
“ ‘96..	64,297	71,642	108,781	109,330.781	425,586	1	4
	434,409	329,430	589,609	591,946.828	2,303,325	19	11

THE MYSORE MINE. RETURNS FOR 1896.—ORE STAMPED, TAILINGS TREATED, AND GOLD PRODUCED.

12 Months to 31st Dec. 1896.	Quartz treated and Gold extracted.			Tailings treated and Gold extracted.			Tailings treated by Cyanide process.			Total Bar Gold produced.	Standard Gold.	Net amount realised.
	Quartz stamped.	Bar Gold extracted.	Produce per ton of Quartz.	Quantity of Tailings.	Bar Gold.	Produce per ton of Tailings.	Quantity of Tailings.	Bar Gold.	Produce per ton of Tailings.			
Tons.	Ozs	Ozs.dwt.gr.	Tons.	Ozs.	dwt. gr.	Tons.	Ozs.	dwt. gr.	Ozs.	£	s.	d.
January	5351	8893	1 13 6	4570	999	4 9	1820	307	3 9	10199	10290.126	40,211 17 2
February . . .	5050	6186	1 4 12	3600	803	4 11	1750	306	3 12	7295	7303.594	28,379 17 0
March	5540	8042	1 9 1	3200	591	3 17	1820	301	3 7	8934	8995.843	34,972 19 11
April	5714	8088	1 8 8	3300	601	3 15	1705	260	3 7	8969	8974.084	34,881 13 0
May	5400	7162	1 6 13	4880	1350	5 13	1845	333	5 13	8845	8837.150	34,342 19 6
June	5328	7429	1 7 21	4380	1357	6 5	1610	169	2 2	8955	9005.828	35,024 10 8
July	5454	7621	1 7 23	4350	1167	5 9	1670	250	3 0	9038	9085.736	35,374 5 2
August	5300	7774	1 9 8	4460	1202	5 9	1760	157	1 19	9133	9181.025	35,766 13 3
September . .	5060	7736	1 10 14	4300	1400	6 12	1677	192	2 7	9328	9365.517	36,478 6 7
October	5290	7935	1 10 0	4405	1142	5 4	1820	254	2 19	9331	9397.259	36,590 15 11
November . .	5300	8031	1 10 7	4440	1059	4 18	1890	251	2 16	9341	9405.564	36,622 5 5
December . .	5510	8006	1 9 1	4640	1214	5 6	1750	193	2 5	9413	9489.055	36,939 17 9
	64297	92903	1 8 22	50525	12885	5 2	21117	2993	2 20	108781	109330.781	425,586 1 4

Selecting two of these operations, of which we have the returns from the commencement, the accompanying tables speak for the progress and production.

As regards the working and output of the Kolar Field generally, we append the interesting table on pages 784 and 785, extracted from an able article on "Gold Mining in the Colar Field of Mysore, India," in the *Mining World* of October 16, 1897.

In the above tables the amounts realised on the sale of the gold sold in London are given; but from these amounts the 5 per cent. royalty of the Mysore government must be deducted, and then the mining expenses, which are, of course, given in the annual reports of the mining companies. The mining expenses are, in all cases, much higher than was to have been expected, seeing that native labor is usually so cheap in India; but this is properly a question for the shareholders and the companies to settle among themselves. At any rate, the dividends of the paying concerns have been so satisfactory for several years that this question has not been of sufficient importance to call for serious consideration, while the reported reserves of stone available for treatment at the mills are sufficient to keep the question in abeyance for some time to come.

The next systematic exploration of the Dharwars has been carried on for some years in the Raichore Doab of the Nizam's dominions, about three hundred miles north-north-west of Hyderabad, at a place called Wondalli, which now gives its name to the company engaged

NUNDYDROOG MINE.

Total returns from the commencement to date.

DATE.	Tons of quartz crushed.	Tons of tailings treated.	Oz. bar gold from quartz and tailings.	Ounces Standard Gold.	Amount realised.
Year ending—					£ s. d.
December, '82..	132	....	13	9.768	37 13 5
" '83..	335	....	35	24.828	95 19 6
" '86..	152	....	141	129.893	505 7 2
" '87..	890	....	1,546	1,474.859	5,737 18 10
" '88..	3,887	....	6,922	6,738.058	26,230 10 3
" '89..	3,781	....	6,127	5,840.155	22,773 7 1
" '90..	9,495	....	15,634	15,096.841	58,911 18 1
" '91..	11,750	1,508	23,592	22,809.745	89,084 3 5
" '92..	18,176	5,950	31,223	30,155.373	117,635 5 9
" '93..	25,760	6,989	27,734	26,458.405	103,107 13 2
" '94..	29,750	7,625	29,657	28,336.163	110,304 8 9
" '95..	32,975	7,775	38,923	36,966.126	144,079 14 10
" '96..	39,490	7,990	44,925	43,148.721	168,166 19 9
	127,975	30,379	141,239	134,909.415	525,658 16 6

NUNDYDROOG MINE. RETURNS FOR 1896.—ORE STAMPED, TAILINGS TREATED, AND GOLD PRODUCED.

12 Months to 31st Dec. 1896.	Quartz treated and Gold extracted.			Tailings treated and Gold extracted.			Total Bar Gold Produced.	Standard Gold.	Net amount realised.		
	Quartz stamped.	Bar Gold extracted.	Produce per ton of Quartz.	Quantity of Tailings.	Bar Gold extracted.	Produce per ton of Tailings.					
Tons.	Ozs.	Ozs. dwt. gr.	Tons.	Ozs.	dwt. gr.	Ozs.	Ozs.	£	s.	d.	
January	2800	3162	1 2 14	700	161	4 14	3323	3190.618	12,436	4	3
February	2700	3172	1 3 12	660	159	4 20	3331	3221.263	12,538	11	8
March	2800	3351	1 3 22	700	199	5 16	3550	3431.101	13,358	10	0
April	2740	3374	1 4 15	680	189	5 13	3563	3440.204	13,395	19	9
May	2750	3384	1 4 15	700	187	5 8	3571	3431.562	13,355	16	10
June	2410	3431	1 8 11	680	158	4 16	3589	3404.599	13,264	6	7
July	3550	3689	1 0 19	700	114	3 6	3803	3614.626	14,095	16	5
August	4000	3813	0 19 2	700	105	3 0	3918	3755.546	14,655	1	1
September	3900	3986	1 0 11	640	94	2 23	4080	3915.999	15,275	7	9
October	3950	3984	1 0 4	600	97	3 6	4081	3924.687	15,305	8	10
November	3950	4003	1 0 6	610	82	2 17	4085	3929.226	15,322	18	9
December	3940	3950	1 0 1	620	81	2 15	4031	3889.290	15,162	17	10
	39490	43299	1 1 22	7990	1626	4 2	44925	43148.721	168,166	19	9

TABLE SHOWING THE HEADS OF STAMPS ERECTED, TONS OF QUARTZ CRUSHED, OUNCES OF GOLD PRODUCED, AND VALUE, BY THE COMPANIES NOW AT WORK IN THE COLAR FIELD OF MYSORE, INDIA, FROM DEC. 31, 1896, TO SEPT. 30, 1897.

Month.	MYSORE.				NUNDYDROOG.				BALAGHAT-MYSORE.			
	Sts.	Tons.	†Ozs.	£	Sts.	Tons.	†Ozs.	£	Sts.	Tons.	†Ozs.	£
Jan.	90	5,500	9,510	37,135	70	4,000	4,107	15,317	25	1,823	176	636
Feb.	...	5,100	9,523	37,159	...	3,700	4,242	15,944	...	...	...	...
Mar.	...	5,530	9,631	37,909	...	4,000	4,284	15,964	...	...	...	...
April	...	5,700	10,014	39,298	...	3,600	4,294	16,078	...	...	...	...
May	...	5,400	10,242	39,884	...	3,620	4,639	17,443	...	...	...	...
June	...	5,200	10,254	40,242	...	3,900	4,633	17,473	...	...	...	...
July	120	5,312	10,309	40,286	...	4,125	4,772	17,962	...	...	...	...
Aug.	...	7,550	11,008	42,830	...	4,155	4,784	17,780	...	...	...	...
Sept.	...	7,267	11,037	*42,769	...	4,055	4,845	*18,775	...	...	...	...
Total	120	52,559	91,528	357,512	70	35,155	40,600	152,736	25	1,823	176	636

Month.	OOREGUM.				CHAMPION REEFS.				MYSORE WEST & MYSORE-WYNAAD (TANK BLOCK).			
	Sts.	Tons.	Ozs.	£	Sts.	Tons.	†Ozs.	£	Sts.	Tons.	Ozs.	£
Jan.	110	5,673	4,513	16,879	140	7,408	9,848	37,541	20	1,000	503	1,937
Feb.	...	5,409	4,671	17,316	...	7,113	9,971	37,843	...	1,100	594	2,291
Mar.	...	5,542	4,690	17,562	...	7,373	10,006	38,066	...	1,300	810	3,123
April	...	5,650	4,759	17,888	...	7,320	10,159	38,702	...	1,400	911	3,506
May	...	5,880	4,808	18,102	...	7,563	10,232	38,941	...	1,500	915	3,508
June	...	6,026	4,632	17,354	...	7,355	10,276	39,119	...	1,400	919	3,540
July	...	5,689	4,667	17,450	...	7,442	10,279	39,339	...	1,400	927	3,578
Aug.	...	5,708	4,617	17,350	...	7,428	10,435	39,792	...	1,400	934	*3,620
Sept.	...	5,653	4,612	*17,872	...	7,270	10,570	*40,959	30	1,400	961	*3,686
Total	110	51,230	41,969	157,773	140	66,272	91,794	350,302	30	11,900	7,464	28,789

Month.	MYSORE REEFS.				NINE REEFS.				COROMANDEL.			
	Sts.	Tons.	Ozs.	£	Sts.	Tons.	Ozs.	£	Sts.	Tons.	†Ozs.	£
Jan.	26	727	237	895	40	153	56	*217	20	1,400	853	3,245
Feb.	...	412	182	683	...	253	105	*407	...	1,250	1,025	3,865
Mar.	...	233	123	466	...	237	63	*245	...	1,200	1,075	4,061
April	Not announced.			375	...	...	...	...	...	1,300	1,105	4,122
May	...	...	...	...	...	...	...	...	...	1,100	1,142	4,287
June	...	...	...	...	...	...	...	...	...	1,100	1,158	4,361
July	...	...	...	...	...	...	...	...	...	1,250	1,170	4,397
Aug.	...	...	...	...	...	...	...	...	...	1,300	1,178	4,455
Sept.	...	...	...	...	...	...	...	...	...	1,300	1,105	*4,282
Total	26	1,372	542	2,419	40	643	224	869	20	11,200	9,811	37,075

† Returns from all sources.

* Estimated at £3⁷/₈ per ounce.

The Mysore West Co. and Mysore Wynaad Co. own and work conjointly the Tank Block. The Goldfields of Mysore Co., in addition to the above returns, have yielded more than 1,000 ounces through the cyanide process and amalgamation.

† The return from the Balaghat-Mysore Mine was obtained, not from a fresh crushing, but by a treatment of tailings.

MONTH.	TOTAL FOR MONTH, 1897.	TOTAL FOR MONTH, 1896.
January	113,082	88,144
February	115,508	103,163
March	117,396	100,273
April	119,969	102,550
May	122,165	102,413
June	122,089	118,341
July	123,012	99,955
August	125,827	102,278
September	128,343	105,055
Total	1,088,111	922,172

on the lately-started mine works. Mr. Foote wrote of the place in 1889 :

“This Maski band is at the present time being energetically prospected by the prospecting staff of the Hyderabad (Deccan) Company. They have discovered very large numbers of old workings, many of them of considerable size and depth, proving beyond a doubt that a large and important gold-mining industry existed here a long time since, probably in the peaceful times before the Mussalman invasions. Many of the workings had evidently been deliberately filled up, probably to conceal them from the enemy. Dr. King and I paid a flying visit to this goldfield quite lately, and were shown several very important old workings near Wandalli and Topuldodi, to the north of Kavital (Kautala of the country people), besides numbers of lesser ones. The workings have in many cases been followed down to between forty and fifty feet, but then water comes in and prevents further exploration till pumps can be rigged up to drain them. This will be done very shortly, and the old workings will then be bottomed, when it will become possible to reach the undisturbed lodes and ascertain their real value. In the meantime encouraging shows of gold have been obtained from crushings of bits of the lodes left as props to the shaft walls. We saw two groups of ‘mullockers,’ or the small mortars in the rock in which the old miners pounded up the ore, or ‘mullock.’ One of these, close to the Topuldodi camp, showed the ordinary small mortars rather larger and deeper than half a cricket-ball, with several larger ones, like inverted dish-covers. The other group, about a mile north-west of the Wandalli camp, shows large, shallow, saucer-like hollows in the solid, tough trappoid. In these the ore was crushed, not by hand, but by working great rounded granite crushers, between half a ton and a ton in weight. The size of these crushers is so great that they must have been worked with some kind of framework by

which to get leverage to move them easily. A considerable number of these great crushers are to be seen, and several lie in their proper hollows. They must have been brought from several miles distance, and at no small expenditure of labour. It is abundantly evident that a great mining industry was once in progress in this Dharwar band; and there are at present good grounds for hoping that the reefs to be reached may, as in the case of several of the Kolar mines, turn out really rich enough to be profitably worked in European fashion."

Since this was written, we have watched a good deal of the further exploration with an interest begotten of early geological wanderings, and have had several opportunities of testing the excellent quality of the stone brought up,—a dark-grey, glassy quartz, with strong free gold, very like the stone first operated on at Kolar. A considerable advantage attaching to the enterprise is the comparative proximity to the Singareni coal field, from which much of the fuel used at the more distant Kolar field is supplied.

Looking next to the main display of the metalliferous series in this South Indian region, it must not be forgotten that these two gold tracts of Kolar and Wondalli are but the most eastern outlying belts. The much more extensive occurrence is in two great bands, or belts, further westward, the southern ends of which lie near Mysore city itself, whence they run north-north-westward for some three hundred and fifty miles, until they become hidden under the Deccan Trap flows of the Belgaum and Kaladgi districts of the Bombay presidency. Between these two big belts there are some fourteen or fifteen small outliers, all of which are enumerated as auriferous in the Mysore administration reports, one of them (Kempinkote) being now under a working mine company. In the greater band Mr. Foote refers to nine auriferous localities in the Mysore territory and one (the Dambul gold-field) in the Dharwar district, as marked by gold washings alone or situated close to old mine excavations.

The further direct continuity, or evident continuation, of the South-Indian transitions with those further to the north, or eastward in the peninsular region, is completely obscured by the great volcanic outburst now exhibited at the Deccan Trap area of more than 350,000 square miles, which spreads out over the Bombay presidency northwards into Rajputana, and eastwards by the central provinces to the edge of western Bengal. It is difficult, therefore, to correlate the rocks of central India, or those of western Bengal, and the central provinces, with the Madras Dharwars, although they are all sub-metamorphic and metalliferous. Still, the character of much of the eastern rocks is essentially Dharwar, while the Rajputana strata are not so clearly related.

In Rajputana the story of gold relates wholly to washings, except in one case, where specimens of gold in the matrix are reported, traditionally, to have been found in the old copper mines of Khetri. Very many gold-washing places are known in the central provinces, their sources being, no doubt, among the adjacent transition rocks, though some are supposed to be derived from quartz in gneissic areas; but there is no satisfactory record of any old mines other than those of lead and copper.

Western Bengal and Chota-Nagpore became famous some seven years ago, through many wild and speculative ventures in what were generally called the Bengal gold fields. At that time little more was known of this rather out-of-the-way and thinly-populated (mostly by aboriginal tribes) country of petty native States than that it consisted of a more or less schistose and trappoid area surrounded by the gneissic or crystalline series, in which gold was washed for; and that there were several old mine excavations, evidently for copper or lead, with perhaps one set of pits and drives having auriferous indications. Anyway, the gold fever was on to such an extent that geological survey warnings and deprecation were of no avail to allay it; and it practically burned itself out through preliminary trafficking in company formation and promotion, rash importation of machinery now lying idle and decaying in rushed-up mills, badly organised explorations, and false reports of discoveries and production. Only at the end, when a few men were driven to real efforts at exploration, with little money left, was any really valuable result obtained in the ascertainment of the fact that there were cases of ancient mining with filled-in shafts and adits, as well as old dump heaps; and that auriferous ore-stone having a bedded character is associated in some force with the hornblendic and chloritic schists. Confidence in this region of Indian gold-mining, however, had sustained too rude a shock, and funds for further work were not available; so the true condition of Chota-Nagpore remains a problem, even in the face of large and richly-auriferous samples of gold quartz from at least one mine.

The remaining tract of the peninsular area is that of Wainad, already incidentally referred to, but differing from those treated of, as in the Gneissic and granitoid rocks, which constitute the more prevalent and foundational series of the country. As with most of the precious ore tracts, the apparently richer part of Wainad is held under native tenure, with the mineral rights attaching thereto. The Nelmumbur Rajah is the landholder of this particular part, his chief village being in the Malabar plains and situated close to some stream washings, whence, at regular seasons of the year, a fair amount of good yellow gold is washed by his people. The Wainad portion of

his estate is on what was once a fine coffee-bearing plateau, 3,000 feet above sea-level, which joins to the loftier (7,000 feet) British mountain land of the Nilgiri district. The lower upland is scored with the white outcrops of strong quartz reefs, auriferous in many places, particularly about Devallah; and there are several sites in this land of swampy flats, between wooded and cultivated undulations, for gold washing. The gold from the reefs is light-coloured, and so rather poor in quality,—a feature well known to the people, the choicer finds to them being, as they say, the “mud gold,” which they can always get in small quantity from any spadeful of the surface-soil in some parts of Davallah. The country-rock of the upland is gneiss of various kinds, occasionally deeply weathered to a clayey rock, more or less gritty with the unaltered quartz foliæ, the foliation, and, indeed, the bedded arrangement of the series, having a W. S. W.—E. N. E. strike with a southerly dip. The reefs, sometimes fully twelve feet thick, and in one case about nine miles long, run generally N. N. W.—S. S. E., with an inclination to the eastward. Extensive working by the old miners is evident among the many reefs and their leaders around Devallah; but the gold extracted appears to have been gained mainly from the leaders, the more massive bodies of the reefs themselves having been neglected.

A preliminary geological survey report of this field was published in 1875, in response to a request from the Madras government, in the interests of a section of the coffee-planting community, which had been engaged for some years in desultory prospecting at the washings and reef outcrops. A brief *résumé* was given of all previous explorations and attempts to utilize the gold, and a favorable estimate was formed on the geological conditions and results of hand and improvised stamp treatment of the reef quartz.

Following this, the services of the late Mr. Brough Smyth, a specialist on gold mining in Australia and latterly minister of mines in the colony, were secured for a time by the government of India, when a further more elaborate and extended prospecting of the country was carried out with improved results, so that a successful development seemed assured. For, where the geological surveyor had run the average of his crushings to only about twelve pennyweights to the ton of quartz, Mr. Smyth's samplings occasionally amounted to more than an ounce to the ton, while, curiously enough, he, as well as the geologist in his day, happened to break up lumps of stone which quite blazed on the fractured surfaces with spangles of gold, which stone, of course, yielded remarkably rich samplings. Reports thus loaded were naturally seized on, and in one case there was a jumbling, in a telegraphic dispatch to London, of several ounces to the ton instead of an ounce

to several tons, which was sufficient to rouse the speculative market into violent operation. About this time the opening out of the country was, we feel sure, mismanaged in great part through the loss of a guiding hand by the death of Mr. Smyth. The largest operations were above ground and in the air, and it was only when work along this line ceased to be interesting that the reefs themselves were tackled. Several fresh explorations were organised on rearrangement of mining concessions and companies with further raising of capital, but the returns for any continued period of working always dropped to an average of three or four pennyweights in the ton,—certainly a sufficiently gloomy ending to all the ancient story of this being the Eldorado of biblical history, let alone the promise which public records and actual geological and mining survey foreshadowed. And yet there are those who still see a future of successful gold production when Wainad is more easily approachable by carriage or rail transport. This matter of transport was always a crushing item in expenditure, for there was either only the long route from the west coast ports over the forest-clad plains of Malabar, with weak bridges, and thence up the mountain road, orghat, for 3,000 feet; or else there was the longer, though partially-railed, journey from the Madras side, with a final pull over the mountainous country of Mysore or the Nilgiris. Heavy machinery, imported for the great opening out, is still lying where it was abandoned on the bad parts of the western route, and a similar fate holds pieces of metal plant on the Nilgiri side.

The aspect of a profitable development of the gold-bearing rocks of peninsular India has changed, to all appearance for the worse; but it must not be forgotten that few, if any, of the tracts outside the Mysore area have had the continuously well-engineered and strong financial treatment that has been exercised within that region. When we ourselves knew Kolar in the early days,—that is, at the pegging-out of the first block in the ten-square-mile concession,—the venture was quite as problematical as any other talked of. Indeed, we can go so far as to say of Kolar itself that it might now be still the bare upland it was in 1875, instead of the present busy scene of flourishing mine and mill work, had it not been that the strong protest of the late most capable and worthy Captain Plummer, then of the Nundydroog mine, against shutting down, was fortunately acted on by the Mysore mine, when the disposal of their remaining capital was a matter of vital consideration.

As for Burma, most famed of all the eastern lands for gold and all the precious stones, even less can be said for it than for India proper as a gold locality, because the reported places have not as yet given any good results, nor are the geological conditions fully ascertained.

Upper Burma, towards the main confluence of the Irrawaddi, shows occasional reefs, or, perhaps, interbedded ore bodies, and some prospecting has been done ; but few thoroughly reliable results can be expected until the country has been more opened out. Communication, transport, and labour are most serious difficulties, which will stand until there is an open railway route to Assam and Bengal. Other gold sources are reported along the eastern side of the Irrawaddi valley, below Mandalay, and thence southward through Tenassarim ; but these also wait more careful and systematic prospecting than has been exercised on them hitherto, and, as in upper Burma, communication is difficult, and labour unobtainable except by importation from India. There is no doubt, however, that gold production existed in Burma before the British occupation, in sufficient quantity to excite the cupidity of its old native rulers, who exacted taxes, in certain parts of the country, which had to be paid in gold ; and in upper Burma, particularly about Wuntho, gold can still be washed for. One of us visited this region, after a preliminary geological survey had been made, when it was evident that good yellow gold was obtainable in places from small leaders, and even from quartz ledges of definite extent ; but these ledges were neither rich enough or of sufficient continuity to hold out any hope of profitable working. Of course, in a wild, jungle-clad country, like much of upper Burma, there may be larger reefs, but so far none have been met with. Travellers in the old days found it very hard to believe that the barbaric splendour of gilded pagodas and palaces, with the gem-like sparkle of their friezes, screens, and countless pinnacles, arise mainly from layers of gold leaf from China, with cunningly-arranged bits of looking-glass or glass castings from the Italian and English markets ; but such is the fact. The king and his court kept the gold and precious stones to themselves, and these treasures were, after all, but the result of the hoarding up of dynasties.

It was, indeed, this long-continued treasuring of gold and jewels, not only in Burma, but at every old court and mansion of any state in India, which enabled the potentates and noblemen to display the stores that dazzled the eyes of their visitors and gave color to the belief that gold was actually obtainable in the country in correspondingly large quantity. Whatever the production, it was mainly gained from nature's own concentration processes of rock degradations and river siftings at a slow pace, and from distant sources, not only in peninsular India, but in the vast Himalayan region to the northwards,—altogether too slow a turn-out for these modern days of active British occupation and development, which demand a richly progressive opening-up like that of Mysore, or such as may confidently be expected from some of the many other tracts of auriferous occurrence indicated above.

THE APPLICATION OF ALTERNATING CURRENTS TO ELECTRIC TRACTION.

By Charles Henry Davis and Howard C. Forbes.

THE application of the alternating current for transmitting electrical energy to great distances has seemed to many the means of solving the problem of operating main lines of steam railroads by electric motors in place of steam locomotives. By means of the alternating current the energy from a water-power (or other source) can be carried a great distance to a railroad, which would thus obtain its motive power at an apparently trifling cost; hence in such cases it seems advisable, at first sight, to throw away the locomotives and operate the road by electricity. Much that is written on this subject leads to the conclusion that already sufficient development and perfection have been attained to make economical this substitution of electric traction on our present steam lines. A good deal has been said, however, by enthusiasts, that cannot be substantiated by critical analysis and comparison, although we have hope for future developments. The progress made during the past ten years is such that no one is justified in saying positively that "electricity will not be able to do it economically"; nevertheless the statements made in an article in *THE ENGINEERING MAGAZINE* for October, 1897, that (1) "where water-power is always available within a FEW hundred miles," (3) "for *desert* railways, where water cannot be obtained," etc., "electric traction is eminently suitable" may be dangerously misleading to the uninitiated, as we shall show in detail later. While many of those interested in the development and application of electricity have laid the greatest stress on its advantages as a means of utilizing "a cheap source of power," now it is understood that such a source of power may be the most expensive to develop, without any corresponding advantage in its use. The question of a "cheap source" of power is not the main issue. Assuming every other condition of maintenance and operation to be the same, and as economical in the one case as in the other, then that system which produces the cheapest power at the rim of the driving wheels, and not at its source, is the one to use. The problem is, therefore, not solely a question of the original cost of the power, although the advantage of cheap power is obvious, but rather the concentration of power and its long-distance transmission coupled with a cheap source, *versus* operation by small isolated units,—the steam locomotive.

In the May and June (1897) issues of THE ENGINEERING MAGAZINE, the article on "Electric Traction under Steam Railway Conditions" gave a detailed comparison of the advantages and disadvantages of these two systems as applied to our present steam roads; in brief, the conclusions were that electric traction can be profitably used:

- (1) Where units are light, frequent, and run short distances.
- (2) Where gross receipts will be increased more than gross expenses by the use of light and frequent units.
- (3) Where competition of parallel roads using light and frequent units compels the change.
- (4) Where higher speeds are required than can be attained by steam locomotives.

In these papers the use of direct currents transmitted over short distances was assumed, and the use of alternating current was not touched upon. The purpose of this article is to discuss the application of alternating-current motors and transmission lines to the various problems offered by our present steam-railway systems, and to bring out more particularly the apparent limitations of the possible developments of this application.

In discussing this question we shall first state the requirements of electric traction, and describe the application of alternating currents thereto. We shall then show that, although it may be possible to use the alternating current indirectly in operating railways, it does not follow that "where water-power is always available within a few hundred miles" it is advisable to use it, even for a new railroad. Finally, we shall take up specific cases illustrating the application of alternating current to railroads, and shall work out in detail a definite case, showing the relative economy in first cost and yearly expenses of operating a trunk line in two ways,—*viz.*,

- (1) By long-distance electric transmission from a cheap source of power;
- (2) By electric power station situated near the railway.

In the operation of railways, whether electric or steam lines, one requisite is that the speed of trains must be controlled by the operator; the variations of speed must be numerous, and the change from one to another must be sufficiently smooth to cause no discomfort to the passengers or excessive strain on any of the apparatus. The electric railway motor operating by direct current has long been used for this work with satisfactory results, and in its latest forms is sufficient and serviceable under the rough usage to which it must necessarily be subjected. The general appearance of one of the best forms of direct-current motor for railway service is shown in Fig. 1. The motor is

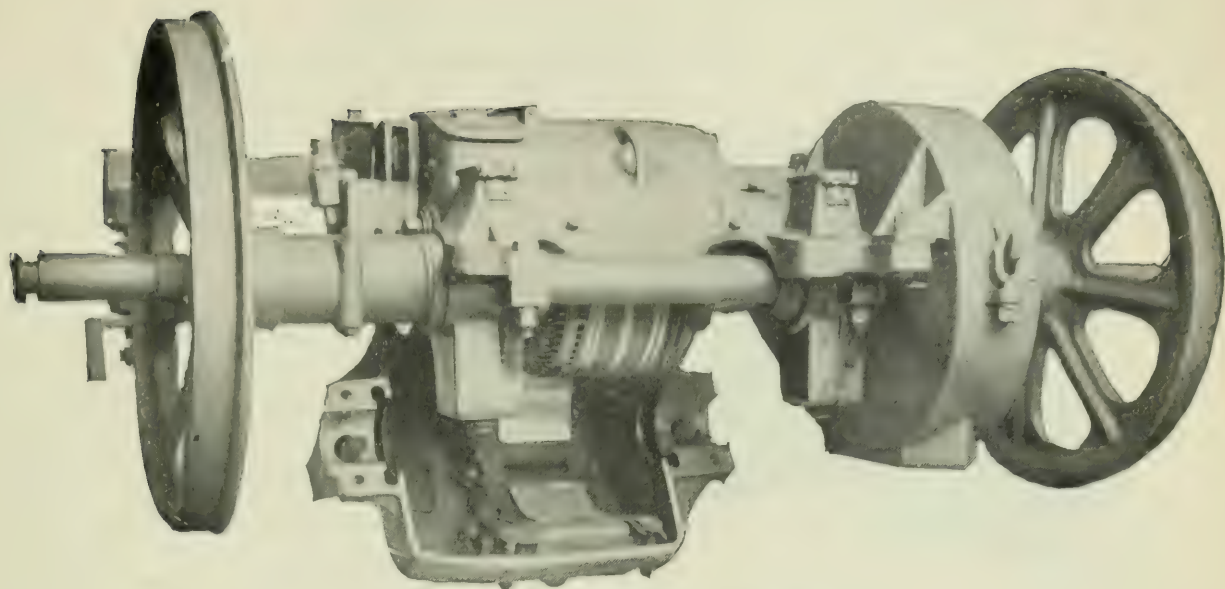


FIG. 1. DIRECT-CURRENT RAILWAY MOTOR.

protected by an iron waterproof case, and is geared directly to the axle of the car. In the direct-current motor the speed is varied by changing, by a controller, the amount of current supplied. A type of such controller is shown in Fig. 2.

With alternating-current motors the regulation of speed is more difficult. Until the recent development in "induction" motors the so-called "synchronous" motor was the only type worthy of practical consideration. This type derived its name from the fact that of necessity it ran at the same speed as the generator that supplied it with current. Obviously, therefore, the speed could not be varied. Besides, this, the "synchronous" motor would not start by itself under load. Hence it was unsuited for operating railway cars. The other form of alternating motor, the "induction" motor, is capable of speed-regulation to a limited extent, and is continually being improved, so that the future may see developments and improvements beyond our most sanguine expectations. A recent form of induction motor is shown in Fig. 3, while Fig. 4 shows a controlling device by which two variations in speed can be obtained. Alternating-current "induction" motors have certain characteristics which would be of great advantage in railway work. The most important of these is the absence of the commutator. Comparing Fig. 1 with Fig. 3, it will be noticed that the direct-current motor has at one end of the armature a cylinder larger than the shaft and several inches wide, upon which bear the brushes that carry the current. This is the commutator; it is made up of narrow copper strips carefully insulated. The commu-

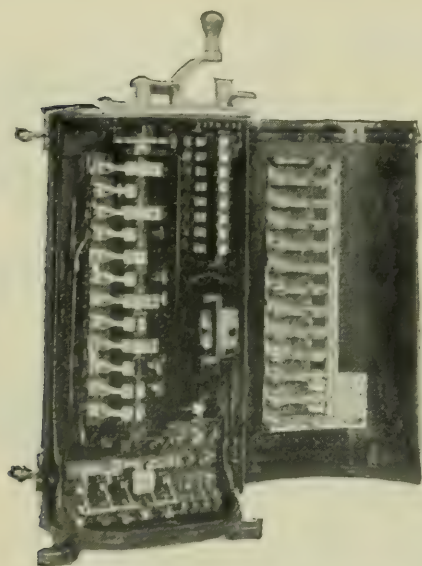


FIG. 2. SPEED CONTROLLER.

tator is the most vital part of the direct-current motor, requiring constant attention ; if allowed to get out of order, it is liable to ruin the motor. On the induction motor, Fig. 3, there is no commutator. In other words, there is no electrical connection between the stationary parts of the "induction" motor and the armature or rotating part, and therefore there is no exposed metal carrying current, and no sparking due to the use of brushes. The "induction" motor is particularly adapted to run in dirty places with a slight amount of care, and will give far better service under such conditions than will direct-current motors, because of the absence of the commutator. On the other hand, the efficiency of the "induction" motor is not so high as that of the direct-current motor, and for railway purposes the means of controlling the speed is far inferior. The development in the use of alternating currents started with a single-phase generator, or, in other words, a machine delivering to the line a single pulsation which alternates in its direction. This current was satisfactory for lighting work, but unsuitable for power purposes, because, as explained before, the motors would not start under any considerable load, and their speeds could not be controlled. Our needs in the direction of power-utilization have led to the development of the multi-phase generators, or, in other words, machines which deliver to the line two or more pulsations, each alternating in direction. The two phase and the three-phase systems are the most usual to-day, although a greater number could be used.

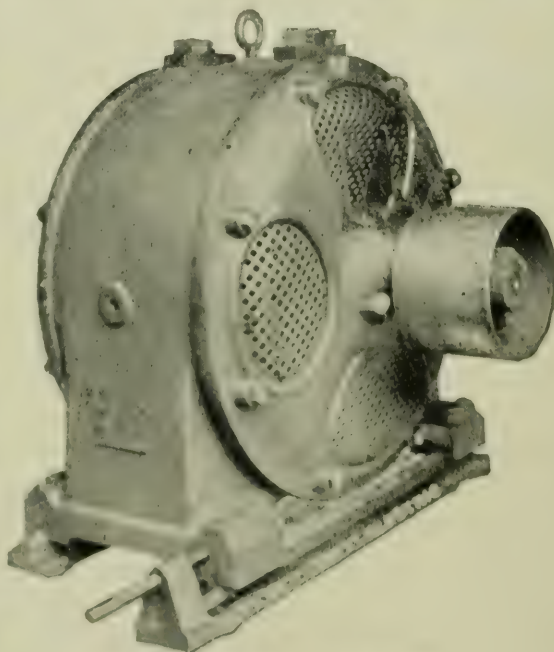


FIG. 3. INDUCTION MOTOR.

The use of multiphase currents has the following advantages :

- (1) They allow some control of the speed of motors.
- (2) They provide for starting motors when loaded, but not when over-loaded to the same extent as direct-current motors.
- (3) They facilitate insulation.
- (4) They overcome some of the effects of induction.
- (5) They reduce the cost of conductors.

In short, then, the "induction" motor, like the "synchronous" motor, presents the difficulties of starting under loads as well as speed-control. The two-phase and three-phase "induction" motors have overcome these difficulties to a certain extent, and they offer improvements over direct-current motors.

- (1) They require less attention.
- (2) They give less trouble from dirt, dust, or water.
- (3) They have no commutator.
- (4) They have no moving electrical contacts, (except in special cases).
- (5) There is less danger of burning out armatures.
- (6) They require renewal of parts less frequently.

The disadvantages in their use can be summarized thus :

- (1) They do not readily start with over-loads.
- (2) Their speed cannot readily be controlled.
- (3) Their efficiency is lower.

At present the disadvantages outweigh the advantages, in so far as the conditions of railway work are concerned.

Moreover, there are two other reasons against the present use of "induction" motors, which should have more or less weight, according to the conditions, but which cannot be charged against the motors themselves. We refer, first, to the effect on water pipes due to electrolytic action by currents returning in the ground from the rails to the power station. With the single-trolley alternating-current system the injury to the pipes spreads over the whole area surrounding the tracks, while with the direct current, by running the current from the generator into the trolley wire (trolley positive) and back through the track and ground returns, the deteriorating effect on the water pipes can be confined to a comparatively small area in the vicinity of the power station, where they can be easily watched and taken care of. Second, with the single-trolley system, the effect of induction is likely to cause considerable trouble on the telephone lines. The use of a double-trolley system to overcome these difficulties would lead to other and greater disadvantages in construction and insulation, which would to-day be insurmountable.

It seems, therefore, that the direct application of alternating-

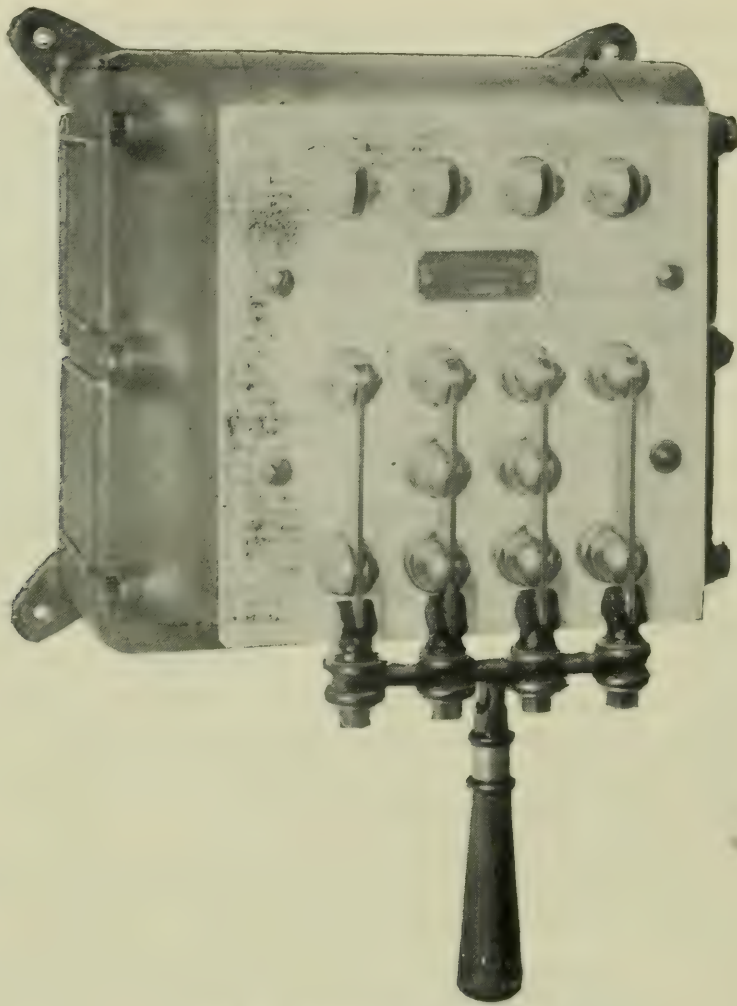


FIG. 4. SPEED CONTROLLER.

current motors to railway systems is not feasible to-day from a practicable standpoint, mainly for the reason that we cannot satisfactorily control variations in speed. Irrespective of the motors, however, the alternating current can be used indirectly in operating railway lines. The method, in brief, is to carry the alternating current from the power station to a point in close proximity to a section of the track. Here the current is changed from alternating to direct by means of the so-called rotary transformer, and then applied as direct current to the cars using direct-current motors, with the usual devices for controlling the speed. This method of using the alternating current introduces an extra transformation, with its concomitant loss, and its use is confined to cases where it is desired to transmit power from a distance. The fact that long-distance transmission can be accomplished more conveniently and economically by alternating

current than by direct is the reason why alternating current is used, and this advantage partly compensates for loss of power in the rotary converter. Alternating currents are better adapted than direct currents for transmitting power over long distances, because with the use of the latter we are now limited to comparatively low pressures, either in the generating plant (1,000-3,000 volts) or the motors (500 1,000 volts), while with the former we can "convert," and thus utilize between the generator and the motor, higher pressures than would be safe at either end. In transmitting currents of electricity over long or short distances there is a necessary loss in transmission, due to the power required to force the current through the wires. This loss is present in all circuits carrying a current of electricity in greater or less amount, depending upon the volume (amperes) of current (squared), and the quality, size, and length of the wire. In cases where large currents are to be carried long distances the loss is so increased that it requires special consideration. The principle involved in all long-distance transmission lines is to increase the pressure (voltage) to as high a point as practicable. This is done because the same amount of power can thereby be transmitted, at a correspondingly reduced current requiring a smaller wire, at the same or less loss, since the power is represented by the product of the current and the pressure. Hence, by reducing the current, the energy lost in the line is reduced in proportion to the square of the current. By thus increasing the pressure and reducing the current the original investment in the transmission line can be kept within reason, and the interest account reduced as well as the loss of energy in the line.

The limit to which this process of reducing the loss in transmission can be carried depends upon our ability to insulate wires carrying high pressures. There is no difficulty in using an alternating current running at a potential of 1,000 to 2,000 volts, for these pressures are common in the outside mains of lighting companies supplying alternating current for incandescent lighting in our cities and towns. For long-distance transmission, however, the pressure must be raised at least 10,000. This is now done successfully in a number of cases; the Niagara Falls transmission line is operated at 11,000 volts, and it is the intention to increase this to 22,000 volts. How soon higher pressures than this will become commercially practicable remains to be demonstrated by the development in the use of present electrical insulating materials or the discovery of new. In order to obtain high pressures, an intermediate step is required between the generator and the line, known as the "step-up" transformer, and another at the other end of the lines, known as the "step-down"

transformer. Generators are built at present to deliver not much more than 2,500 volts, and usually run from 1,000 to 2,000 volts. The "step-up" transformers take this voltage, and raise it, for transmission, to 10,000 or 20,000 volts. At the other end of the line the voltage is reduced to the desired amount, in a similar manner, by a "step-down" transformer, and then applied to the distributing lines, or to the rotary transformer, or to both, as the case may require. High insulation is therefore required from the "step-up" transformer along the transmission line to the "step-down" transformer. The required insulation is secured by special construction in the transformers, which are also filled with oil, and by insulators of special design attached to cross-arms and poles adapted for the purpose. A line insulator of high voltage is shown in Fig. 5.

The path of the current is as follows. A multiphase generator (Fig. 6) is operated by water or steam power, and run at 1,000 to 2,000 volts; the current is then raised to 10,000 volts or more by "step up" transformers (Fig. 7); from here the current is transmitted at this voltage to a so-called sub-station at the other end of the line; here are located the "step-down" transformers (Fig. 7), which take the voltage at 10,000 from the line, and convert it to the proper voltage for street-railway service; the current then goes to the rotary transformer (Fig. 8). This machine may be best described as a motor and generator combined. The alternating current is here applied at one end, and the direct current, suitable for use on the railway lines, is taken off at the other; from here the current goes to the trolley line, to the motor on the car, to the ground, and returns to the rotary transformer at its direct-current end. Where the power is used for other purposes as well as operating railways, many variations of this method are employed.

We have shown so far that the alternating-current motor cannot to-day be used under the cars in place of direct-current motors, or at the head of the train in the form of an electric locomotive; but the usefulness of the alternating current in railway work is confined to the facilities with which it can be transmitted over long distances. On account of the high voltage that can be used in alternating-current transmission, and the saving in the cost of transmission lines resulting therefrom, it is possible to utilize water powers situated at a distance from the railway lines. We now come to the question whether, having a source "where water power is always available within a few hundred miles," it is advisable to utilize it.

Search for a "cheap source" of power must be careful, as its use often results in increased cost of operation and maintenance.

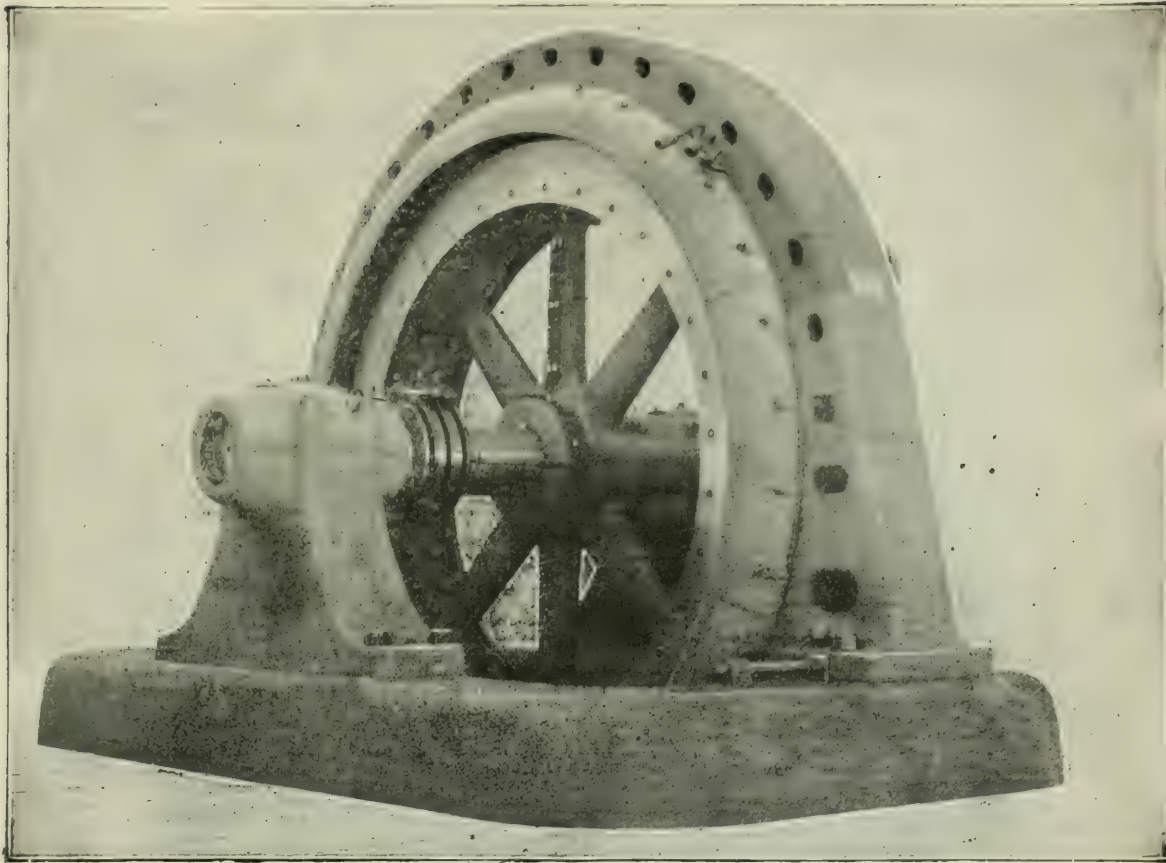


FIG. 6. A MULTIPHASE GENERATOR.

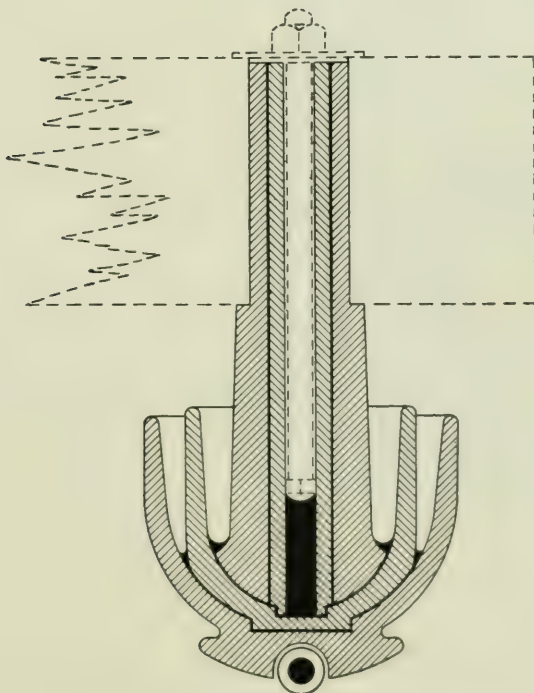


FIG. 5. A HIGH-VOLTAGE INSULATOR.



FIG. 7. A TRANSFORMER.

This more clearly appears when one remembers that "power" on an electric road represents only 11.5 per cent. (fair average) of the total cost per car-mile, while cars represent 19 per cent., track and line 27 per cent., and car labor 42.5 per cent. This power is produced by steam, and the coal item equals about 50 per cent. of the power cost, or 5.75 per cent. of the total cost per car-mile,—a very small percentage upon which to save by the use of a water power situated "several hundred miles" from the railway line and requiring a large outlay to develop it, to say nothing of the cost of the transmission line and its maintenance. Could 46 per cent. of 5.75 per cent. be saved, it would be equivalent to a saving of only 10 per cent. on cars, 7.4 per cent. on track and line, or 4.7 per cent. on car-help, any of which savings probably could be accomplished, in a given case, with a much smaller expenditure of capital. (For further details see "Comparative Economy in Electric Railway Operation," March, 1897, issue of *THE ENGINEERING MAGAZINE*.) Furthermore, the cost of fuel for locomotives on trunk railways is approximately 8 per cent. (fair average) of the total cost per train-mile, which, with present compound engines, would be materially reduced (see "The Enormous Possibilities of Rapid Electric Travel," *ENGINEERING MAGAZINE*, 1897), so that but a very small percentage of the total cost per train-mile can be saved.

We feel that, while continual progress is being made in the direction of applying a combination of alternating and direct electric currents to railways, and while at present, in specific cases, it can be shown to be economical on paper, mainly from theoretical consideration of the physical characteristics, yet at the same time, from a business standpoint, so large a factor of safety must be inserted into such calculations in order to warrant the experiment that the actual transition from steam to electricity on the trunk-line railroads does not seem to be near at hand. At present such a change is hardly warranted, and it is unlikely that it would be accompanied by a saving sufficient to cover the interest and depreciation on the investment necessitated, even considering only that portion of a line running wholly within one hundred miles of a water-power. The deciding factor is the cost of developing and transmitting the power rather than the fact that cheap power can be obtained. The majority of water powers, especially in the eastern part of the United States, have not sufficient head to render the transmission of their power a commercial success to-day over long distances; what future development may bring we cannot say.

While, in general, present trunk lines cannot now be profitably converted to electric traction, even by the use of alternating cur-

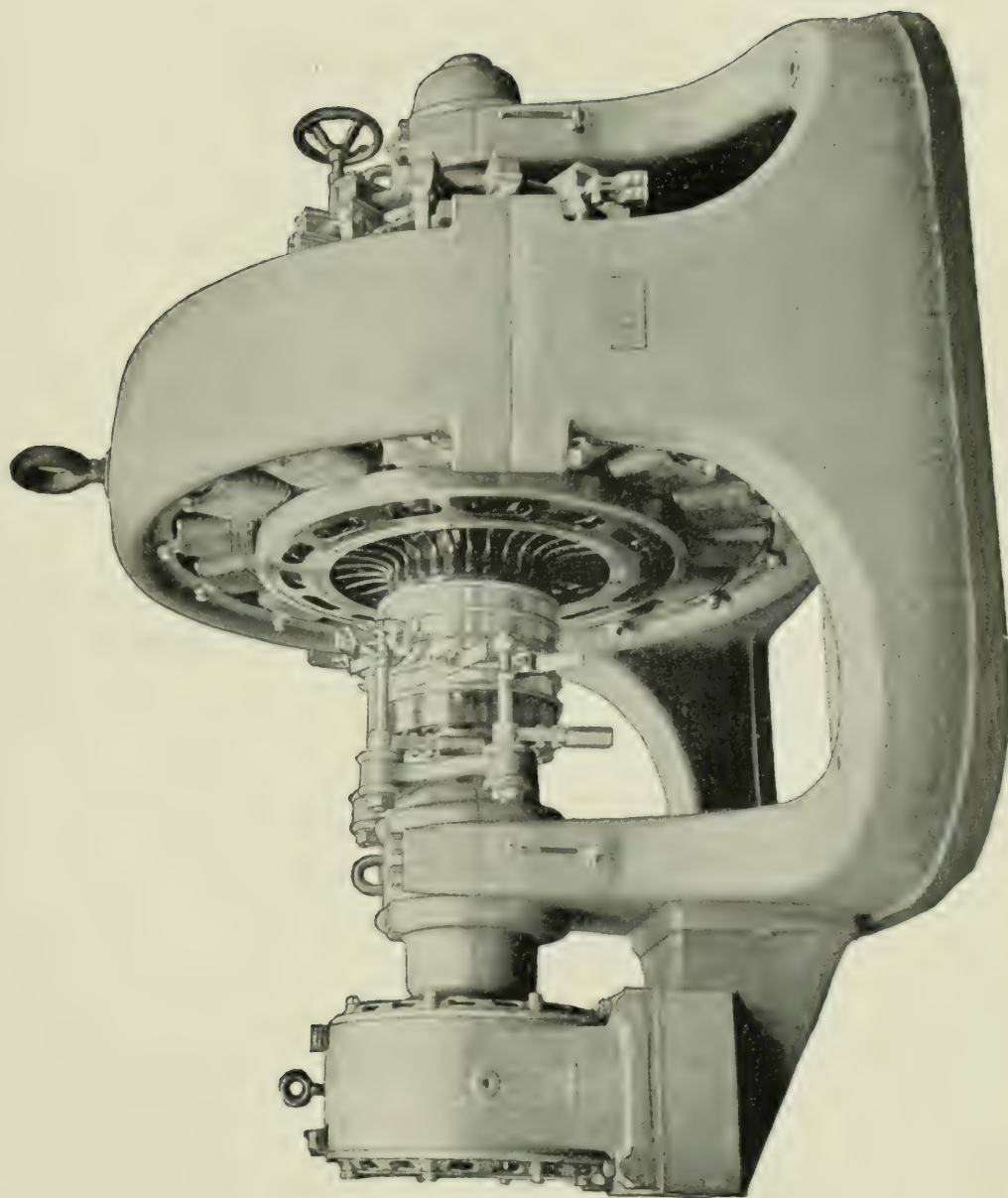


FIG. 8. A ROTARY TRANSFORMER.

rents, parts of such systems may be, and where a new line is to be built, or where very high speeds and short headways are required, it will be advisable to consider electric traction.

To quote from the writer's paper on "Electric Traction under Steam Railway Conditions," in *THE ENGINEERING MAGAZINE*, May, 1897:

"In making a comparison of the use of steam locomotives and electric motors as motive powers, it will be found, in general, that, where the units of transportation are many, light, and frequent, and operated over short distances, the use of electricity will result in lower first cost and operating expenses, and will be more desirable in many ways; while with units that are few, heavy, and infrequent, and operated over long distances, the use of steam locomotives will result in lower first cost and operating expenses, and prove more desirable. Though this general statement is often modified by special conditions, it will generally govern in determining changes from steam locomotives to electric motors, or the choice of one or the other in the case of newly-projected roads."

In the next paper specific cases will be considered.

REVIEW OF THE ENGINEERING PRESS

Progress in Timber Physics.

THE division of forestry of the United States department of agriculture, in its circular No. 18, recently issued, gives some valuable information concerning the subject of timber physics, especially with relation to the influence of size of test pieces upon the results, and to the range of variation in strength which may reasonably be expected.

The tests made at Washington, though unfortunately interrupted by fire, were carried far enough to enable a number of valuable points to be determined, the most important conclusions being:

"1. A difference in strength values derived from a few specimens of the same kind of wood, up to 10 per cent. for coniferous wood and to 15 per cent. for hard woods, can not be considered a difference of practical importance; such differences cannot be relied upon as furnishing a criterion of the value of the material.

"2. The size of the test piece does not in itself influence strength values, except in compression endwise when the size is less than a cube.

"3. Small test pieces judiciously selected furnish a better statement of average values of a species than tests on large beams and columns in small numbers.

"4. A large series of tests on small pieces will give practically the same result as such a series on large beams and columns; hence, there is no need of finding a coefficient, with which to relate the results of the former to construction members.

"5. The influence of moisture on strength appears even greater than the former tests and statements from this division have indicated."

These statements are of the utmost importance in connection with the use of timber in construction, for, if tests on small pieces are sufficient to give knowledge of the strength of a wood within the limits of variation of commercial pieces, there is no need of expensive and incon-

venient tests of full-size pieces, and testing may be undertaken much more frequently than formerly.

"Wood, as is well known, is a non-homogeneous material, and hence is extremely variable in its strength and other properties; so much so that it has often been doubted whether any test series could produce reliable standard values."

When, however, the limits of such variability are fairly well understood, as indicated above, there is no reason why tests should not be of much value. It is in the judicious use of test results that their true value lies.

"Discussions, needless controversies, and false conclusions on the relative value of various wood materials or processes of treatment, have been frequent, having been based on differences of test data, which might have been within the range of variability of each material by itself, the difference being too small to predicate quality of the material in general. Small differences, such as a few hundred pounds in values of 10,000 pounds or more, have been regarded as deciding for or against a whole series of material or a species, or have been utilized to establish a superiority of various processes of treatment or methods of testing or computation."

When it is found, therefore, that the range of variation between the results of tests on full size pieces and on small specimens lies well within the variability of the material itself, the supposed advantage of using large test pieces disappears, while in its place comes the gain due to the greater number of small pieces which can be tested.

An important discovery, in connection with the work of the laboratory has been worked out by Mr. S. T. Neely, and is stated as follows:

"The strength of beams at elastic limit is equal to the strength of the material in compression, and the strength of beams at rupture can, it appears, be directly calcu-

lated from the compression strength; the relation of compression strength to the breaking load of a beam is capable of mathematical expression."

Assuming this statement to be correct,—and it appears to be sustained by the many tests made by the department,—the strength of beams of any desired wood may readily be determined by very simple tests; and there appears to be no good reason why any timber structure should be constructed without a full knowledge of its strength, within the limits of the variation in the strength of the material.

There has been some criticism of the manner in which the materials were selected for these tests, the point having been made that the pieces used represented a much higher grade of timber than is ordinarily used in actual construction. This point perhaps would be well taken, if the results made any claim to a very high degree of precision; but, it having been clearly stated that the variation between the strength of various specimens may reach 15 per cent. of the total strength, it is evident that this point has been fairly considered. Altogether the tests represent good work done in the important line of timber physics, and it is to be hoped that the cessation may be only temporary.

The New Croton Dam.

IN the course of the development of the plans for the collection, storage, and delivery of the water of the Croton valley to New York city the original scheme has undergone a number of modifications. The new aqueduct has been completed, but the idea of constructing the projected Quaker Bridge dam, to impound the entire drainage of the whole water-shed, has been practically abandoned, and, instead, several smaller dams are to be constructed. Of these dams that at the Cornell site, across the Croton river, is the most important, and from an excellent account in the *Engineering Record* some description of the plan, and of the present condition of the work upon it, is abstracted.

"The main structure is a masonry wall, founded on solid rock far below the natu-

ral surface, with a core wall continued into the hillside at the south end, where the bulk of the structure is mostly earth embankment. The north end is curved up-stream, nearly at right angles, parallel to the hillside, to make a long overfall."

This masonry dam will certainly be the largest in the United States, and probably in the world, as its extreme height from bed-rock will be 290 feet, and the length of the masonry portion will be 700 feet. The thickness at the bottom will be 200 feet, diminishing to an 18-foot roadway at the top. The overflow, which extends at right angles with the masonry dam, forms a channel by the side of the dam, providing a spillway of nearly 1,000 feet in length, thus furnishing ample relief for the greatest discharge to be expected.

The cost of the work is estimated at nearly \$5,000,000, and since 1892, when the first contracts were let, nearly half this amount has been expended.

"The diversion and protecting works were costly, and required considerable time to construct, while the excavation of a pit about 1,300 × 500 feet on top, and of a maximum depth of about 300 feet from the highest point of the original surface to the lowest part of the pit, involved the removal of about 900,000 cubic yards of earth, and 100,000 yards of rock, some of it from a depth of 130 feet below the original bed of the river, and the hoisting and conveying of the spoil to considerable distances. The last of this work was completed in September, 1897, and, on October 1, 144,000 of the 650,000 cubic yards of masonry had been laid."

In so important a work as this, where the consequences of failure would be so serious, the greatest care must be taken to insure perfection of workmanship; so especial precautions were observed in preparing the foundation of the masonry upon the bed rock.

The accepted surface of the rock was scraped clean, swept, and washed with a jet of water under heavy pressure. After painting with a wash of pure Portland cement, the bed for each stone was covered with thick cement mortar; then the stone was lowered upon it, raised again,

to observe the impression, and again lowered and thoroughly bedded. Constant and vigilant inspection has been maintained over all portions of the masonry construction.

The handling of the materials involves the use of wire-rope cableways, besides many derricks, trackways, locomotives, and cars; and a force of 750 men find employment upon the masonry construction work.

The progress already made promises successful completion by 1901, all elements of uncertainty being now removed. The dam has been designed by Mr. Alphonse Fteley, the chief engineer of the Croton aqueduct, and president of the American Society of Civil Engineers, who, with an efficient corps of assistants, is in full charge of the execution of the work.

The account in the *Engineering Record* is accompanied by reproductions of a number of photographs showing the progress of the work, at various stages, together with topographical plans and sections, giving a far better idea of the nature and magnitude of the undertaking than can possibly be conveyed by any description.

Hinged Masonry Arches.

THE revival of the past few years in favor of masonry arches has in great part developed from increased study, and the assurance that increased knowledge has given as to the real stability and strength of structures built in accordance with the modern theory.

The old statical theory, which has come down to us from the time of Coulomb and his followers, depended for its demonstration upon certain assumptions which, while convenient, were by no means in accordance with the facts; and the result was the development of empirical rules, which carried with them the usual amount of uncertainty.

Among these uncertain elements the most important was the exact location of the position of the line of pressure at the abutment; and, when, in the case of moving loads, there was a certainty that the position of the centre of pressure at the

crown and at the abutments varied according to the elasticity of the material, the unreliability of the statical theory became apparent.

The results of the important tests made by the Austrian Society of Engineers upon full-sized arches demonstrated so fully the correctness of the elastic theory that it is now no longer open to question, and the present problem is rather as to the best method of so controlling the direction of the forces as to maintain them within the desired constructive limits.

A valuable paper upon the subject of three-hinged masonry arches, with especial reference to long spans, by Mr. David A. Molitor, appears in the *Proceedings of the American Society of Civil Engineers*, and in it are contained some important points concerning the construction of masonry arches.

"Essentially all the harassing features of fixed masonry arches are overcome by the introduction of hinges at the crown and abutments, thus permitting a rigid analytical treatment, and affording almost absolute safety against cracks, even though small settlements may take place in the abutments." The idea was introduced by Köpcke, of Dresden, in 1880, by providing open joints at crown and haunches. Karl v. Leibbrand, at Stuttgart, in 1885, substituted sheet lead for the open joints, and applied cast iron hinged bearings in 1893; these having already been advocated by the author in 1888.

Hinged joints in masonry arches have already been applied successfully in arches of considerable span, and Mr. Molitor gives a list which in itself should be enough to convince the most sceptical that there is no constructive objection or difficulty worthy of consideration.

Among these especially may be noted the Munderkingen Arch, of 50 metres' span, across the Danube, constructed of concrete with a rise of only $\frac{1}{10}$ the span. This was designed by Leibbrand, and its success undoubtedly settled the correctness of the method.

Mr. Molitor presented his paper in the hope that it might be the means of introducing this form of arch construction into

the United States and gives at some length the computations and equations for the three-hinged arch. The graphical method for determining the deformation under unsymmetrical loading or displacement of abutment is developed, and the most reliable values for the moduli of elasticity and coefficients of shrinkage of cement are given, although it is suggested that these should be checked by actual determinations in the case of any given structure.

The paper closes with a complete detailed solution of a problem whose object is the design of an arch to meet certain given conditions. The entire design is worked out in a satisfactory manner. If for no other reason, this portion of the paper should be welcomed, showing, as it does, that the shape of the arch curve should not be arbitrarily selected at first, but should be permitted to develop from the conditions of the problem.

It is, indeed, to be hoped that Mr. Molitor's paper may lead to a more scientific and rational development of arch design and construction in America, and that this most effective, beautiful, and scientific method of spanning openings may be used wherever practicable, to the exclusion of the hideous metallic truss.

The New American Battle-ships.

REFERRING to the decision of the Board of Construction of the United States Navy Department that the three new battle-ships provided for by congress shall have a speed of only 15 to 16 knots, *Engineering News* makes a strong and timely protest against so mistaken a policy, in which protest we cheerfully join. If the recent events of the war between Spain and the United States have demonstrated anything, it has been the supreme value of speed in naval warfare. Under such circumstances, and against the direct opinion of the able Chief of the Bureau of Steam Engineering, Commodore Melville, it appears little short of criminal for the Board of Construction to advise the construction of battle-ships which will be surpassed in speed by at least fifty similar vessels in the possession of other nations.

It is not because fast vessels cannot be built that the sluggish Board of Naval Construction does not recommend them. The Bureau of Steam Engineering offered plans for 18-knot vessels, involving the latest types of water-tube boilers and quadruple-expansion engines, and promising a saving in weight of 350 tons, but this offer, made by engineers who are well known to be entirely capable of fulfilling any requirements which they may accept, has apparently been passed over, in order that existing plans, already more or less antiquated, may be used.

It may not be too late to urge upon congress the magnitude of the blunder which has thus been made. In the light of recent experience, and with the advice of such men as Mahan, in America, and Clowes, in England, the importance of speed in naval warfare is certainly well worth considering; and it is to be hoped that, before it is too late, the wise plans of the Engineer-in-Chief will be adopted, and that the minimum speed-capacity of the new battle-ships may be placed at 18 knots, with liberal premiums for any excess.

Testing Cast Iron.

AMONG a number of valuable papers presented at the Cincinnati convention of the American Foundrymen's Association was one upon the adoption of a standard system of test bars for cast iron, by Dr. Moldenke.

The paper first called attention to the fact that, while in the United States much success has been attained in the production of large and intricate castings, there is need for a closer study of the properties of the material of which they are made. There is practically no attempt at uniformity in methods of testing, and the whole matter is in a chaotic state.

The standard forms and methods of preparing test bars, as used in Germany, were described and illustrated, and a number of practical objections raised.

"We all recognize the fact that, after all, the judging of quality in a material by means of test bars can only be a relative one. Steel, after casting, is subjected to

a variety of heat and working processes, leaving the structure of the finished product in a very different form from that of the original. Cast iron, on the other hand, remains just as cast. As there is no possibility of wiping out the chilling effect of the mould, the variation in structure due to casting temperatures, rate of cooling, etc., the test bars by which a casting is to be judged should approach as nearly as possible the peculiar conditions obtaining at the time."

It is owing to the difficulty of accomplishing this that there is so much diversity of opinion among practical foundrymen. The practice of many foundries—of breaking the first castings made in filling a regular contract, in order to detect any defects in methods of moulding, pouring, etc.—is commended as the most practical plan for articles of moderate size made in large quantity. The next best method is to cut out test pieces from finished castings rejected for some surface blemish not due to extremes of temperature while being poured. This at least will enable a general opinion to be formed as to the quality of the material and its adaptability for the purpose intended.

Dr. Moldenke urged that steps be taken to make the Foundrymen's Association a member of the International Society for the Unification of Methods of Testing Materials of Construction, in order that it might join the work of the other large societies interested in industrial progress, and he expressed his belief that the discussion of the special subject of testing cast iron would lead to the adoption of a satisfactory international code, in which American practice would find recognition.

In a general way he expressed his own views as to the character of standard test pieces, as follows:

"For the tensile test, a bar should be round and of large diameter. The peculiar requirements of the transverse test seem to demand a square and thick bar. Test bars should all be cast vertically, to avoid the variation in strength in the upper and lower sides when cast flat. The effect of a dry sand mould should be obtained, to remove all disturbing influences due to

the varying dampness of green sand moulds. These are a few of the points to be considered in the making of the test bar, its preparation for the machine requiring further study."

In connection with Dr. Moldenke's paper it is interesting to note that the American section of the International Association for Testing Materials has been formally organized with the following officers: chairman, Prof. Mansfield Merriam; vice-chairman, Prof. Henry M. Howe; treasurer, Paul Kreuzpointner; secretary, R. L. Humphrey. These officers, together with Mr. Gus C. Henning, the American member of the council, constitute the executive committee.

Undoubtedly this organization will advance the interest in the work of the International Association, so far as America is concerned and at the next general meeting of the association, in Paris, in 1900, substantial results may be expected.

Compensating Reservoirs.

ONE of the greatest difficulties with which the hydraulic engineer has had to contend in connection with the establishment of gravity water-supply schemes has been the old common-law right of every riparian owner or dweller along a stream to have all of a stream flow past his premises forever. Many a promising gravity water-works scheme has been blocked by the obstruction thus created.

In a valuable paper presented before the recent convention of the American Water Works Association at Buffalo Mr. Stephen E. Babcock discusses this difficulty, and suggests a possible remedy.

By reference to various judicial decisions Mr. Babcock fairly establishes the proposition that the riparian owner has no property interest in the water itself, but a right only to its use as it flows along; indeed, all the American decisions are apparently based on the opinion of Lord Ellenborough that "every man is entitled to a stream of water flowing through his land without diminution or alteration."

The principal difficulty to be met here lies in the question as to the right to the excess flow over and above the normal

flow of the stream, and attempts have been made to show that storm waters, or the waste product of water passing along in times of freshet, also constitute a property value to the riparian owner, and must be accounted for to the owner of the land, as well as the ordinary flow which the machinery may be adapted to use during the greater part of the year.

It is this question of the ownership of the excess flow of water which forms the theme of Mr. Babcock's paper, and the matter is evidently one of much importance, since, by the construction of compensating reservoirs, the excess water may be retained and used for purposes of water-supply without infringing on the rights of the owner of the land so far as the average flow is concerned.

The older decisions take no account of the relative amount of water passing at different times of the year. We have in hydraulic engineering a condition of streams known as the average flow, storm flow, ordinary (or normal) flow, and minimum flow. The average flow may be considered as based upon the entire flow for the year, and is the entire flow of the year divided by the number of minutes or seconds in the year. The ordinary (or normal) flow, is the flow which can be depended upon for eight or nine months of the year, and it is for this flow that a riparian owner adapts his machinery.

Under these conditions Mr. Babcock contends that the storage of excess water works no hardship to the riparian owner, and that so long as the party storing or conserving this water product allows the ordinary and minimum flow to pass down the stream, the riparian owner can have no claim for damages, and the party who conserves the waste water may do what he pleases with it. A number of English authorities are quoted in support of this proposition.

Mr. Babcock then proceeds to show how, by careful gaugings, an equitable division of flood waters from ordinary discharge may be made, and then cites the case of the city of Little Falls, N. Y., in which an additional supply of water was secured by this method.

Testing Bicycles.

ALTHOUGH the bicycle is one of the highest developments of modern machine-design, and represents a remarkable example of evolution in mechanical construction, it is but recently that its mechanical efficiency and strength have been scientifically investigated. Some of the manufacturers have, of late, introduced testing laboratories in connection with their productive work, but for general and public research facilities have only recently been offered.

A very complete testing equipment is now installed in the laboratories of Sibley College, Cornell University, and from a paper by Messrs. A. H. Eldredge and G. B. Preston, published in *Machinery*, we are able to give some account of the apparatus and the results deduced from its use.

Bicycle tests are sometimes made on the road, using dynamometers attached to the machine, and measuring the speed and grade, and some useful information has been obtained in this manner; but, as the local conditions of the road, the actual atmospheric resistance, and the individual characteristics of the rider are all indeterminate qualities, such tests do not give comparable results.

Laboratory tests also have their objectionable features, but, as the conditions are all under control, it is possible by such tests to investigate the action of the various parts, and also to compare wheels of different styles in a scientific manner.

In the laboratory test the rear wheel of the bicycle is supported upon the rim of another wheel directly under the bicycle wheel and in the same plane. This supporting wheel, called the track wheel, takes the place of the road-bed, and by means of it the rear wheel of the bicycle can be driven from the crank shaft through the bicycle gearing at a speed of rotation corresponding to any speed of translation desired. An absorption dynamometer is attached to the axis of the track wheel, and a transmission dynamometer to the bicycle crank shaft.

This apparatus enables any desired conditions as to saddle-load, tire-pressure,

speed, and equivalent grade to be introduced, and the corresponding efficiency to be determined in a comparable manner for any number of wheels, while investigations as to the effect of varying the conditions for a single wheel give valuable information concerning constructive features.

The tests described in the article referred to were conducted for the purpose of comparing the resistance of different types of wheels, made by the same establishment, but differing in weight, shape, and style of gear, the wheels including standard, racer, and drop-frame chain wheels, and also a standard chainless machine.

Tests were also made to determine the following points:

Effect of tire-pressure and saddle-load upon the efficiency of propulsion, both with single and double tube tires of various weights;

The change of resistance due to change of speed;

The effect of the alternate thrust upon the two opposite crank shaft bearings, due to the action of pedaling;

Whether or no a bicycle deteriorates by use;

The relative efficiency of the solid rubber tire, the cushion tire, and the pneumatic tire.

Before making the actual tests, the various parts of the apparatus were run without other load than that due to the resistance of the testing mechanism, so that the necessary calibrations could be made, and the influences due to the apparatus itself could be clearly distinguished from the action of the bicycle undergoing test. The crank shaft of the wheel was driven by an electric motor, with universal-joint connection, thus eliminating any imperfections in alignment, while the speeds were indicated by a tachymeter, and recorded by an electric speed register.

The results of the tests were too voluminous to be recorded here, and in the original paper they are shown in the form of curves, which enable the relative efficiencies to be seen very clearly. Some of the conclusions, however, are of much interest, and may be given.

In the first place, as has already been discovered, the point of greatest influence upon the efficiency of a bicycle is the tire. Different tires, even when of the same make and supposed to be of the same grade, when attached to the same wheel, pumped to the same pressure, and carrying the same load, vary several per cent. in efficiency. In order to determine the efficiency of the other parts of a bicycle, therefore, it became necessary to test it with the tire removed, and a number of such tests are given.

In regard to the influence of the style of frame, it was found that the drop frame and the standard pattern did not vary more than two per cent. in the riding limit, while the chainless machine lay several per cent. below, and the racer an equal amount above; but the entire difference was no more than is found to exist between tires of the same make and grade; so that, for all practical purposes, the various styles may be considered equal.

The influence of the pedaling action, which was imitated by attaching weights to the cranks in such a manner as to give the alternating up-and-down thrust, was greatest on the light racing frame, as might have been expected. It was also greater, within the riding limits, for the drop frame than for the standard, but very small in all three cases.

The difference between old and new wheels was found to be little, if any, more than between two new wheels of the same make.

The pneumatic tire, while shown to be an inefficient transmitting device, is, when compared with the solid and cushion tire, the greatest advance yet made in bicycle construction.

A very interesting feature of the tests was the actual determination of the power exerted by an expert rider. This was done by placing the rider in the saddle and causing him to drive the cranks at a speed corresponding to ten miles an hour. The brake was then adjusted to the greatest resistance that the rider was capable of overcoming, and, from the brake-reading thus obtained, and the known efficiency of the bicycle, the number of foot-pounds per

mile put into the bicycle by the rider was found. This was done with two different riders, both stronger than the average, and the maximum was found to be 40,000 foot-pounds per mile. This corresponds to a continuous pedal pressure of 42 pounds, or, at the speed of ten miles per hour, to one-fifth of a horse power.

Loss of Water from Reservoirs.

IN determining the condition of a reservoir as to tightness or security against leakage, it is necessary to make allowance for such losses as occur from causes other than direct leaks. One of these causes of diminution in the contents is that of evaporation, and in sections where the relative humidity of the atmosphere is low this is amply sufficient to need investigation. In most cases the measurement of evaporation-losses from reservoirs has to be made for each case, as very little recorded information is available, and the conditions vary for different localities.

A valuable paper upon this subject has been prepared by Mr. L. G. Carpenter, of the State agricultural experiment station at Fort Collins, Colorado, and published as a station bulletin. The tests were intended to cover the losses by seepage as well as by evaporation, but it was found that the loss by seepage was less than was expected, and that the loss by evaporation was correspondingly more important.

It is well known from meteorological investigations of humidity that the capacity of the air for moisture depends upon its temperature, upon its dryness, and upon the freedom with which it circulates, and the same conditions appear in connection with lake and reservoir evaporation. As Mr. Carpenter says, "The amount of evaporation depends upon the the temperature of the water, upon the dryness of the air, and upon the wind. The wind brings fresh, unsaturated air in contact with the water surface, and gives opportunity for more vapor to be absorbed. Unless the temperature of the water surface is warmer

than the dew-point of the air, evaporation cannot proceed; if lower, condensation may take place."

The tests were made by observing the difference in level in a standard tank 3 feet square and 3 feet deep, the depth being measured to the nearest thousandth of a foot, twice daily. Corrections for rainfall were taken from the readings of a rain-gauge, and, as tabulated, the monthly averages are given for each month in the year from 1887 to 1897. The maximum evaporation (average) in one month was for July, being 5.44 inches, and the minimum for December, being 1.22 inches, the average yearly evaporation for eleven years being 41 inches.

It might at first be supposed that the elevation of Fort Collins—4,990 feet above the sea—helped to increase the evaporation, but tests made upon the Sweetwater reservoir, in southern California, and only 220 feet above sea-level, showed an evaporation of more than 59 inches per year, while the Arrowhead reservoir, 5,160 feet above sea-level, gave but 39.15 inches per year. While the monthly losses showed variations, Mr. Carpenter considers that for the whole year the evaporation, in all probability, is considerably less at high elevations than at low ones.

Measurements on the lakes showed that the results were somewhat larger than indicated by the tank, this being due to the freer action of the air and to the increased surface exposed by the waves, and the principal conclusion arrived at is that the allowance for evaporation in open reservoirs is about 60 inches per year.

Assuming, then, a loss of 5 feet in depth per year, an area of 100 acres would require $\frac{3}{4}$ cubic feet per second for the whole year to make good the losses for evaporation; one of 500 acres would require $3\frac{1}{2}$ cubic feet per second,—considerably more than would be used to irrigate the whole area.

Mr. Carpenter's paper gives the results of the tests, fully tabulated.

THE BRITISH PRESS

Wasteful Steam Pumps.

THE recent attention which has been directed toward the wastefulness of the auxiliary machinery on shipboard is also revealing similar lack of economy in stationary plants. A paper read before the Municipal Electrical Association, by Mr. J. A. Jeckell, on "Steam-Using Plant" shows that the accepted type of steam pump is indeed a wasteful device.

One pump tested by Mr. Jeckell showed a steam-consumption of 160 pounds per horse power per hour, and another a steam-consumption of more than 300 pounds. "These pumps were the duplex direct-acting, and were supposed to be very efficient. Moreover, these tests were made after the pumps had been thoroughly overhauled by the makers, and been made as good as they could be made; therefore, what must have been the consumption of steam when the pumps had been working some time? It is too awful to contemplate." Some pump-makers are willing to give a guarantee of 50 pounds of steam per pump horse power, but, as a rule, pump-makers are averse to giving an exact guarantee.

The reasons for the wastefulness of these pumps are most evident. In the first place there is little or no expansion, the high-pressure steam following the piston for the full stroke, and then being discharged into the air with a "bark," which tells at once of the wasted energy which it represents. Then again, the duplex type of pump, or, indeed, any type of pump with steam-thrown valves, is most unreliable as to making its full length of stroke, and in many instances working clearances of more than 25 per cent. of the stroke are found. Since there is little or no compression, this clearance space is filled with live steam at every stroke, and the ensuing waste can readily be understood.

For continuously-operating machines like air and circulating pumps it certainly seems as if a really economical driving

engine might be installed, leaving the independent devices to be used as emergency apparatus, for use only when absolutely necessary, and upon occasions when economy of steam was altogether a minor consideration.

Twenty Years' Mining Progress.

IN his presidential address, delivered before the Mining Institute of Scotland, Mr. James Forgie reviewed some of the salient features in the progress of coal mining during the past twenty years, and although his remarks referred more directly to mining in Scotland, yet many of the points apply equally well to other parts of the country.

Although twenty years is not a long time in the history of a country, yet when applied to the examination of a single industry it reveals the progress in a marked degree. As compared with England, Scotland has shown the greater development; the output of coal in 1896 in Scotland, showing an increase of 54 per cent. over 1877 as against 45 per cent. for Great Britain, and while the output per man in Great Britain has remained stationary, it has increased in Scotland by 13 per cent.

In looking for the causes of the great development which has taken place during this period we find much of it to be due to the growth of the railway system, and the extension of trade which followed that growth. At the beginning of the period under consideration the coal output simply met the normal demand, and, especially in Scotland, was drawn from the shallower field. The laying off of numerous new collieries and the sinking of deeper pits followed the increased demand, and the output of coal in Scotland, as in Great Britain, has gone on increasing from year to year, although the experience of the coalowner and coalminer, from a financial and wages point of view, has not been that of continued prosperity.

The increased output on the Continent

as well as in the United States, and more recently in Japan, not only of coal, but also of iron and machinery, has gone on to such an extent that these countries can in a great measure meet their own wants, and in some cases are now in the position of being exporters and competitors both in foreign markets and in the United Kingdom.

The advance in the demand for fuel has been somewhat modified by the progress which has been made of late in its economical use, both in the manufacturing trades and also in steamships. The introduction of high pressures and multiple expansion has reduced the coal consumption in the best steam engines to about $1\frac{1}{2}$ pounds per horse power per hour, or less than half what it was at the beginning of the period under consideration.

The real intrinsic value of a ton of coal cannot be estimated from the cost of producing it and the price received for it. When used in manufactures at home—in generating power and for heating, lighting, and many other purposes—its value is far reaching and incalculable, and it will have an increasing value each succeeding year as science and invention find new methods of stripping it of its stored energy. It creates wealth, and provides labour and the necessities of life for a teeming population. When exported, all the value of a ton of coal to the country is simply the miserable price received for it.

In referring to the waste of coal, which is probably greater at the collieries than anywhere else, various plans have been suggested for utilising the very small coal, which, while good fuel, will not pay the cost of transportation. The attempt to manufacture it into briquettes has not met with much success in South Wales, but the plan of burning it in a gas producer to the form of fuel gas, either for transmission and combustion, or for use in gas engines offers possibilities which have as yet not been fully grasped. The mere combustion of the waste coal is not enough, but an outlet for the power thus provided must be made, and this opens up the far larger question of power distribution from central stations to distant points, and its solution is not yet fully accomplished.

Many improvements have been made in the actual working of collieries, especially in the ventilation and in the haulage of the coal. At the surface, also, many improvements have been introduced, including boilers engines, winding ropes, and minor details, but perhaps the greatest improvements has been in the methods of handling the coal and preparing it for the market. Improvements in screening, sizing, cleaning, and washing by the use of elaborate machinery have enabled seams to be worked which would otherwise have remained unworkable, and not only have the lives of many collieries been extended far beyond all expectation but dead and dismantled pits have been resurrected and reworked.

With the improvements in production there has also been a substantial advance in safety to the miners and by extensive legislation and regulation the loss of life has been very materially reduced, so that in every direction, except, perhaps that of commercial and financial prosperity, the coal mining industry has during the past twenty years fully kept pace with the industries of the United Kingdom.

The Liverpool Automotor Trials.

THE trials of heavy automotor vehicles at Liverpool, which are very fully described and discussed in the *Automotor and Horseless Vehicle Journal*, have contributed materially to the knowledge of the capabilities and defects of these vehicles as at present constructed.

Unlike the French "poids lourdes," the vehicles tested at Liverpool were mainly intended for the carriage of merchandise rather than passengers, and all those which made the attempt were of the steam motor type. The full account of the trials, with detailed description of the vehicles and maps and profiles of the routes are so completely given in the account above referred to, that only some general reference to the occasion will be made here.

As might have been expected, the various machines met with numerous difficulties, but on the whole the cause of automobilism as a thing of practical, commercial value, received a distinct impetus.

The trials demonstrated that loads of 5 tons can be moved at an average speed of four miles an hour over steep and badly made country roads at a cost far less than can be done by horses drawing the same load. In some cases the haulage of these loads by horses would require such a number as to make the cost prohibitive, and in no case could a cart horse be expected to maintain a mean speed of four miles per hour for 8 to 10 hours continuously.

The results, accomplished as they were over roads far from satisfactory, should do much to bring this mode of merchandise transport into general use. As the *Automotor* remarks editorially:

"These trials have, in fact, revealed possibilities about road locomotion which even the most sanguine hardly anticipated. They mark the inauguration of cheap internal transport, and the first to avail themselves of the many advantages of motor vehicles for the collection and distribution of heavy goods, will, if our information is correct, be the railway companies."

The principal mechanical defect which the trials developed was the unsatisfactory behaviour of the wheels, and here there is decided room for improvement. "The question of the proper design of wheels is not a difficult one, and the real cause of such failures as occurred seemed to be due to the inability of the designers to grasp the different conditions under which the wheels of an automotor must operate, as compared with an ordinary vehicle.

Most of the makers of motor vehicles cling to the wooden cart wheel, which is essentially a roller, intended to be pulled along by the axle, and receiving its turning force at the circumference. Such a construction is manifestly unfit for transmitting power under the severe conditions existing during the trials.

In such matters it is important that the traditions of the wheelwright be carefully ignored and the wheels, and indeed the entire running gear of a motor vehicle, be designed upon correct mechanical principles, regardless of the contrast which the result may give in comparison with the appearance of the orthodox cart or wagon.

The makers of bicycles have learned to proportion the parts of their productions upon entirely different rules from those still retained by the carriage makers, although there is some evidence that these latter are not above appropriating some of the good points which have thus been worked out for them. So the builders of automotors should strike out for themselves, and leave the old vehicle traditions aside as fully as the constructors of railway carriages have learned to ignore the constructive features of the stage coach. If the Liverpool trials have taught the automotor builders nothing more than this they have done much to advance the cause of motor vehicles, and render the next competition still more successful.

Safety Mining Lamps.

IN a series of papers upon the safety lamp problem, by Mr. H.W. Halbaum, published in the *Colliery Guardian*, the present status of the safety lamp with regard to explosions in mines has been very fully discussed.

The old system, represented by the Stephenson and Davy lamps, was based upon the idea of preventing the flame within the lamp from reaching the explosive gas mixture without. That this most desirable result was in great measure accomplished, is fully admitted, but at the same time the safety lamps constructed on the principle of the obstruction offered to flame by small apertures, or wire gauze, had various defects which have rendered it desirable to find something better, if possible.

In view, therefore, of the desirability of substituting some form of electric lighting in mines, in the place of luminous flames, numerous experiments have been made, with a view of ascertaining the possible danger of ignition of mine gases, either by electric sparks, or by conductors rendered incandescent by the passage of the electric current.

These experiments have been carefully examined by Mr. Halbaum, and in his concluding paper he gives some interesting opinions both as to the various methods of mine illumination and also the extent to

which the laboratory tests represent the real state of affairs likely to occur in a working mine.

In the first place the old form of miner's safety lamp was never intended to enable the miner to remain in an explosive atmosphere with impunity for any length of time. The flame of the lamp, indeed, could not pass through the gauze of the Davy and ignite the gas without, but the gas could penetrate within the lamp and burn inside the flame chamber. This at once gave warning to the miner that he had entered into a dangerous working, and also indicated the possibility that the protecting gauze might soon become red hot, and thus ignite the mass of explosive air without. The warning thus given enabled the miners at once to leave the dangerous working and report the condition of affairs without delay.

The weak point of the electric lamp, however well enclosed and free from danger of ignition of mine gases, is the fact that it gives absolutely no indication of the presence of dangerous gases, and is entirely independent of the nature of the air which may be surrounding it.

For this reason Mr. Halbaum strongly advocates the most improved forms of the flame safety lamp, such as the Marsaut or the Mueseler, believing them to be far more desirable than an electric lamp which gives no indication of the presence of gas, and if broken is liable to ignite the mixture without warning.

"Every practical pitman at the present day will admit that the ordinary type of safety lamp constitutes a safety lamp chiefly because it betrays the character of the outer atmosphere. If an explosive atmosphere is present, we do not want a lamp that will burn, and a man that will attempt to work in such an atmosphere. We want a lamp that will give indications of the presence of such an atmosphere, and a man who is not insane enough to attempt to work in an atmosphere which is totally unfit for respiration."

The advocates of the new lamp admit this point by advocating the use of the electric lamp and a separate indicator for firedamp and carbonic acid. This pro-

posal simply nullifies all the advantage claimed for the new lamp, as it requires the Marsaut lamp to be superseded by the electric lamp and also by a firedamp detector which depends for its combustion upon the outer atmosphere, and hence possesses the very faults urged against the Marsaut.

An especial objection to periodical tests of the mine atmosphere is found in the fact that explosive gases are apt to be given off in sudden outbursts, and the great value of the older form of lamp lies in the fact that it gives warning of danger at any time, without involving the uncertainties of "trying" for gas at irregular intervals.

For these reasons, among others, Mr. Halbaum fails to see how the mining fraternity can reap any net benefit from the proposed substitution of the incandescent miner's safety lamps for such satisfactory and well-tried lamps as those known as the Marsaut, the Mueseler, the bonneted Clanny, and several others of equal merit that might be mentioned.

Gas-Works Machinery.

THE general impression made by an inspection of a gas works is anything but favourable to the idea of the use of machinery for the various operations, as the dust, gas, and general deteriorating influences present appear to be such as to prevent the use of any but the coarsest and roughest kind of machinery. The work must be done, however, and, if the conditions are such as to make it hard upon machines, and, of course, still harder upon men, this kind of labour ought to be saved, if possible.

In a paper presented before the Society of Engineers, Mr. Edward Alfred Harman describes very fully the machinery used in gas works.

"Gas-works machinery has to deal with numerous combinations of unpurified gases, acids, alkalies, gritty and impure water, oils, and spirits. Some of the machinery is required to draw out hot coke from benches of ovens at a distance of from three to four feet from them; while the machines are subjected to all the in-

fluences of heat from the furnaces and material they are employed upon. The machinery, therefore, is not working under the same conditions as at other engineering works, where most of the influences named are absent. To meet these special requirements, necessity and experience have designed a whole collection of machinery, which possesses distinct features of interest and importance."

While the manufacture of gas is primarily a chemical operation, there are so many mechanical features about that it is also a manufacturing process.

One of the most important pieces of gas-works machinery is the exhauster, the function of which is to reduce the pressure upon the dip pipes,—not as is generally supposed to draw away the gas directly from the retorts. This relief of resistance cannot draw air in from the retorts, as is sometimes erroneously assumed, since the dip pipes are fully sealed, but it does prevent the accumulation of back pressure in the retorts. Back pressure is objectionable for several reasons. Besides facilitating the production of a hard carbon deposit upon the sides of the retort, it also detains the gas in contact with the incandescent coke, thereby causing serious decomposition.

The exhausters also act as force pumps, to deliver the gas into the holders, the lightness of the gas being by no means equal to overcoming the resistance offered by the weight of the huge masses of framework and sheet metal.

The exhausters are usually driven by steam power, but Mr. Harman makes a good point when he says that gas engines should be used for this and other power service about a gas works. It is, indeed, somewhat of an anomaly to be generating steam, necessitating powerful boilers, when an ample supply of gas power is always available.

In the handling of coal and coke there is room for much labour-saving machinery. Coal-stacking machinery is fully reviewed in Mr. Harman's paper, especial attention being called to the installation at the Copenhagen gas works, and the coke conveyors at Birmingham and at Bruges.

The coal transporters used are mainly of the cantilever type, with traveling bucket, while the coke conveyors are made with endless bucket chain, which delivers the quenched material to a revolving drum screen, beneath which the wagons are placed to receive the various sizes as they are delivered.

Power-charging machinery is now in use for delivering the coal to the retorts, each machine having an adjustable hopper, provided with a feeder box for regulating the weight of the charge of coal. The charger consists of a scoop and carriage, the latter containing the apparatus for emptying the coal out of the scoop. The scoop enters each retort twice in making a complete charge, the coal being thrown alternately on each side of the retort. The power-charging machine is fitted with propelling gear, and arranged to travel up and down the retort house.

Drawing machines are also used, being arranged with rake bar provided with raising, lowering, and traveling gear, usually operated by compressed-air cylinders.

It is a question in Mr. Harman's mind whether in view of the efficiency and capacity of modern stoking machinery, there is any room for economy by use of the more recent invention, or re-introduction, of inclined retorts. With the existing machinery a retort may be discharged and recharged in a few seconds with comparative ease, and this can hardly be improved upon by the use of the inclined retorts.

There is still room for the exercise of much mechanical ingenuity in the reduction of wastes in gas works. In spite of the reduction in time by the use of machinery instead of hand-charging, a large quantity of gas is wasted. The recovery of the spent lime is also a field for investigation; while the possibility of compressing the coke dust into briquettes should not be overlooked.

The waste water from the sulphate-of-ammonia manufacture deserves consideration. It now passes away hot, and amounts to millions of tons annually, representing a waste of energy in the

form of heat which is certainly preventable. An enormous amount of cyanides in coal gas is also being lost, although efforts are now being made to recover it.

The whole development of gas-works machinery is now rapidly passing from the early rule-of-thumb stage to the domain of scientific engineering, and the results cannot but prove satisfactory alike to engineers and gas-works managers.

Steam Laundry Machinery.

ALTHOUGH machinery has been used for a long time for cleansing fabrics in the factories during the operations of the original manufacture, it is only recently that they have been used in connection with laundry purposes. From this we may except the well known mangle, which is of mediæval origin, the name being derived from *maganon*, in the same manner as the military "mangonel."

A very full account of modern laundry machinery is given in a paper read before the Institution of Mechanical Engineers by Mr. Sidney Tebbutt, and published in *Engineering*.

Mr. Tebbutt gives the French the credit for being the pioneers in this field, although it is almost entirely from the United States that the present machines come.

From the obvious conditions of the work, the machinery for use in laundries must be constructed with the utmost care to provide against wear and tear of the articles upon which the work is done, and it must also be simple enough to be readily handled by untrained labour. Every provision must be also made for speedy repairs or renewals of important parts, as the nature of the work demands freedom from interruptions or long stoppages.

Laundry machinery can be broadly divided into that which cleanses and that which finishes.

The cleansing machinery requires the use of much hot water, and as all the heating of washing liquors is accomplished by turning the steam into them direct, it is very important that the steam should be free from grease and other impurities. It is therefore desirable that the exhaust steam from the engine which drives the

machinery should be used for some other form of heating, such as drying coils, or the like, and no exhaust steam permitted to re-enter the boiler.

Much care should be taken with the valves and piping, as there is often much loss from leaky pipes and fittings, while the constant use to which the valves are subjected soon gets them out of order if they are not thoroughly well made in the first place.

The methods of washing vary in detail, but involve the same general principles. The clothes are soaked for a time in cold water containing a little soda, then again in water warmed to about 100° F., after which a third solution of soap and soda at about 130° F., is used. The mechanical portion of the operation generally consists lifting the clothes a certain height out of the water and then allowing them to fall into it again. This is accomplished by the use of an outer cylindrical casing partly filled with water, within which is a revolving cylindrical cage in which the clothes are placed. The hot washing liquid can flow through the spaces between the bars of the revolving cage, and the direction of revolution being continually reversed the desired action is readily obtained. These machines are generally made entirely of wood secured with brass wood screws, in order to avoid the formation of iron rust or mould.

The supply of steam and water and liquor is introduced into the ends of the outer cylinder, and in some forms of machine, circulating devices are provided to compel a flow from the outer to the inner case and round again to the outer casing.

Similar machines, made entirely of metal are also used to be operated with steam at a pressure above that of the atmosphere, and these are supposed to be more efficient than the low pressure machines, as the high temperature effects a more thorough cleansing, besides disinfecting the articles. At the same time excellent results are obtained with the atmospheric machines, and thousands of them are in daily use.

The drying is performed in the first stage by centrifugal extractors, after which the articles are generally passed to a drying

room either provided with steam heating coils, or through which air is forced by means of a blower, after having first passed through an exhaust steam heater. Some articles are ironed at once when taken direct from the centrifugal machines.

The finishing machines used in laundries include the various machines used for ironing, of which there are a great variety. They all act mainly in the same way, although they differ greatly in design and capacity. In nearly all there is a hard polished surface of metal, which is heated by steam or electricity; and a second hard surface of metal or wood, which is padded over with layers of felt covered with a wrapper of cotton sheeting. The padded surface holds the article which is being ironed, so that it can be made to rub against the polished heated surface, while allowing for irregularities of thickness in the article itself. Mr. Tebbutt gives detailed descriptions of the most important ironing machines at much greater length than is here possible, and much mechanical ingenuity has been expended in this direction.

The whole subject of laundry machinery is one which will well repay investigation, and the skill of the engineer will find it a fertile field for the exercise of inventive ability.

The Duty of the Consulting Engineer.

AN interesting question has recently arisen concerning the extent to which the consulting engineer should feel bound to consider the interests of others than his immediate clients when reporting on technical subjects connected with the promotion of joint-stock companies, and an editorial and some correspondence in *The Engineer* contain some comments worth considering.

When an invention has been brought to the point of mechanical success and the financial promoter is called upon to launch it in the commercial world, it is generally necessary to have a report upon the matter by some consulting engineer of reputation, and upon his report prospectus is usually framed, so far as the merits of

the device are concerned. It is frequently found that the opinion of the engineer is of importance in points decidedly beyond the mere mechanical features of the project.

"It is not every excellent invention which will bring in money. It is not every scheme for a harbour, a dock, or a railway that possesses commercial worth commensurate with its engineering merits; and the man who can recognize the truth in this way is able to do service as a consulting engineer, of infinitely greater importance than the man who can only say whether a given scheme can or cannot in his opinion be carried out."

In the case under discussion one of the most prominent consulting engineers in Great Britain included in his report upon a mechanical device an opinion regarding the validity of the patents, this being a feature which was not acceptable to the promoters of the scheme, however desirable a warning it might have been to intending investors. The result was not altogether satisfactory to the managers of the company, but the engineer objected to the publication of extracts from the report, and insisted that it must be used as a whole, or not at all.

It appears that the engineer held that the expert, in making a report, is bound to make himself master of the whole subject, and that he will not have discharged his duties unless he places all the information he can obtain in the hands of his employers. He must tell not only the truth, but the whole truth. The great body of experts will probably hold that this is going too far, and, indeed, in the correspondence which the matter has elicited it is maintained that there is no good reason why the consulting engineer should transgress the well-known rules of practice of the profession, and do much more than he is called upon to do.

The engineer who is called in to report upon the construction of a proposed railway is not expected also to report upon the question as to the commercial value of the scheme; that is left for other specialists to determine; and, so far as the interests of the prospective shareholders

are concerned, they must be protected by others than the engineering fraternity, principally by the rule of *caveat emptor*.

In regard to the case at issue, it is also a question whether an *ex-parte* opinion regarding the validity of patents, by one to whom all the information on that part of the subject has not been submitted, is proper matter to be incorporated in a report upon mechanical features.

In most cases such a matter requires the skill and research of the specialist in patent investigation, with a knowledge of existing precedents and decisions, and for the engineer to assume, uncalled upon, that it is his function to include in a mechanical report matters which clearly belong to another phase of the subject, and to insist that this irrelevant matter must be quoted along with the opinions upon the mechanical features, is, to most minds, an unwarrantable extension of the functions of the consulting engineer.

The Paris International Exhibition.

IN view of the peculiar conditions affecting exhibitors at the coming exposition at Paris, an editorial in a recent issue of *Engineering* contains some very pertinent remarks.

In the first place it is understood that the system of classification is such that it is quite possible—even probable—that an exhibitor will not be able to keep his exhibit together as a whole, but be compelled to divide it and scatter it among various buildings. This system of grouping like products together will doubtless contribute very largely toward the unity of group exhibits, and add much to the educational value of the exposition, but it will be a matter of much inconvenience and additional expense to the exhibitor.

One thing is very apparent, even at the present stage of affairs, and that is the fact that the competition is to be, not between individuals, or firms, but between nations, and the exhibits of each country, considered as a whole, are to be pitted against those of rival nations. "For this reason," as H. R. H. the Prince of Wales said, in his address to the Royal Commission, "the display of similar or identical objects by different exhibitors should be avoided as much as possible, and efforts should be made to secure variety with a view of making the most of the space available. It is difficult to avoid some duplication when several manufacturers of similar articles wish to show their goods, and it would be invidious to give the preference to one out of many, but it ought not to be impossible either to form joint exhibits, giving as complete a representation as possible of particular industries, or for manufacturers to come to some agreement among themselves which would bring about the same result. Such a plan, though it might call for some self-sacrifice on the part of individuals, would secure a degree of completeness which could not otherwise be attained, and would go far to promote the common interests of the industry as a whole."

As *Engineering* well remarks: "The great inducement to exhibit—of making trade, and securing awards—must become secondary incentives. Commercial enterprise must give place to patriotic desire to show a united front against foreign industrial enemies, and British manufacturers must fall into line—the German line—and accept the system of exhibiting by collectivities. If this can be done there need be no fear of the result. Time will show whether it is practicable."

THE CONTINENTAL PRESS

The Theory of Retaining Walls.

ALTHOUGH the subject of retaining walls and the proper proportions which must be given to resist a given earth thrust has been discussed by many writers and is embodied in most treatises on civil engineering, practice has shown that the results are not always satisfactory. This may be due to defects in the theory, or more probably to the existence of conditions which the theory has neglected to take into account, but which persist in making themselves felt in actual practice.

For these and other reasons, Herr Iszkowski has reëxamined the subject, and contributes what he terms a "rational" theory of retaining walls to the *Oesterreichische Monatschrift für den Oeffentlich Baudienst*. Some of the points made will bear consideration.

The fundamental question involved is that of the actual pressure exerted by the earth, and it is usually this which is made the subject of assumptions not in accordance with the actual facts. Instead of being a solid prism, acted upon only by the force of gravity and the resistance of friction upon its surface, the nature of the earth enters largely into the manner of its action in sliding or breaking.

The angle of repose of loose earth can readily be determined for any given nature of material; but, when a bank slides or breaks down under the pressure of earth behind it, the angle of rupture is different from the angle of repose, and in many cases the surface is not that of a straight slope, but, rather, a concave break, usually of the same form and curvature for the same materials.

Taking these facts into consideration, Herr Iszkowski deduces a formula from which the angle of rupture can be computed for different kinds of earth under the varying conditions of actual practice, and a table enables the more usual angles to be taken at once.

The paper is a valuable addition to the

literature of the subject considered on its theoretical side, but, as a matter of fact, the chief difficulty in the application of any such method of computation is the fact that the nature of the filling behind a retaining wall is rarely known at the time the wall is designed, the wall generally being constructed first and then filled with any loose material which may be available. Therefore computations based upon the specific gravity of the backing and its angle of slope can be considered only as approximate, and a large margin must be allowed for a material which may at times be almost liquid and at others frozen into a mass, like rock.

Electric Motor Plows.

SEVERAL months ago we referred in these columns to the introduction of electric motors for the purpose of operating agricultural machinery, and now we have to note a very full account of improved devices for this purpose in an article by Dr. Müllendorf, in the *Elektrotechnische Zeitschrift*.

The general principle upon which electrically-driven plows are operated is not greatly different from the well-known Fowler system of steam plowing, in which a gang plow is hauled across the field by a cable operated by a portable engine. In the electric system, however, the motor, instead of being a portion of the stationary mechanism, is mounted on the plow, and travels with it.

Instead of a cable, the motor acts upon a chain, secured at each end to traveling anchorages on each side of the field, the chain passing around a sprocket wheel geared to the motor upon the plow. The mechanical details of this portion of the mechanism are readily understood, and very simple. As each furrow is traced, the anchorages are moved forward, and the reversible plow is started on the return travel.

It necessary, however, to provide some

means of conveying the current to the travelling motor, and it is in this portion of the operation that room for ingenuity is offered. Any system must be simple enough for use in the rough surroundings of open farm work, and any desired field must be readily and fully covered at a moderate cost, if the system is to compete either with steam or animal power.

In the Zimmermann system, shown in the journal above cited, the two wires are carried across the field by the side of the path of the plow, trolley arms reaching out to make the contact. The wires are supported at intervals upon ingenious travelling supports, which reach out and hold the wire from above, allowing free contact to the underrunning trolleys, which are of the sliding variety.

The wire supports are low, as there is no occasion to provide head-room beneath them, and are provided each with one sliding foot and one roller. This permits them to remain steady during the passage of the plow, as the direction of its motion is at right angles to the roller, while, when the anchorages are shifted, the supports are readily shifted with them, as the conducting wires are kept taut. A simple system of poles extending over the boundary lines of the farm and connected with the power station enables this little temporary trolley line to be connected for any field very readily, and the anchor cars are provided with reels of trolley wire to enable fields of any reasonable width to be spanned.

There is a manifest advantage in having the motor mounted on the plow, as it is there entirely under control of the man on the plow, who can regulate the motion according to the demands of the situation. In this respect it is superior to the steam plow, bearing much the same relation to it that the electric motor car does to the cable tram, the former having control of its motive power to a much greater extent than the latter.

The cost of plowing by electricity is, of course, the item which will control its introduction. Figures are given as to the cost of the original plant and that of operation, but these are of little compara-

tive value at present. The real advantage of any such system must lie in the operation in connection with a central power station from which numerous users draw current. Where a convenient source of power is available and current can be supplied to a number of agricultural establishments for all power purposes, as well as lighting and possible heating, the electric system of plowing will undoubtedly come into extensive use. Indeed, the advent of the electric plow may help to bring the attention of agriculturists to the widening scope of electrically-transmitted power, and lead them to become interested in schemes for bringing current to their neighborhood. The introduction of the electric motor on the farm will undoubtedly come with increasing appreciation of the advantages of available power and light at all times.

Ship Models and Experimental Tanks.

THE importance and value of tests made upon models of proposed vessels in experimental tanks is conceded by all shipbuilders, and, notwithstanding the expense of the apparatus involved, the information obtainable in this manner is held fully to justify the cost.

Most of the study which has been given to the subject, however, has been devoted to the relations which the performance of the model bears to that of the full-sized vessel, and, since the original experiments of Froude, and the formulas deduced by him, the mechanical features of such testing-tanks have been improved mainly by the introduction of recording devices, which enable all the elements under observation to be obtained automatically.

Some interesting tests have been made recently by Professor Engels, of Dresden, upon the influence which the form of the channel has upon the speed of the model, or, rather, upon the resistance which is opposed to its motion, and a discussion of his experiments is given by Herr Schromm in the *Zeitschrift des Oesterr. Ingenieur und Architekten-Vereines*.

These tests show clearly that the shape of the tank has an important influence upon the results of the tests, and that, i

tests made upon different tanks are to be at all comparable, the channels should at least be of similar section, while, if the test speeds are to be used for deduction of results to be expected in open water, a correction factor should be applied, this correction having been determined for the tank upon which the trials were made.

Professor Engels used a single model upon a tank the shape of whose channel could be altered, and, by making a number of tests at various speeds upon each form of channel, he obtained data for the construction of speed curves. The result showed that the curves differed for each shape given to the cross-section of the channel, all other factors having remained constant.

Apart from the important bearing of this fact upon the conclusions to be drawn from model trials, it brings up the subject of the best form for the cross-section of ship canals, so far as the production of the minimum resistance to the progress of the vessels is concerned.

When the size of the channel is very large, compared with the immersed section of the ship, of course the shape or slope of the sides is a matter of comparatively small influence upon the resistance; but, in the case of most canals, where there is only enough width to permit two vessels to pass each other, the slope or shape of the sides produces an important effect, especially as the speed of the vessel is increased.

Hitherto the shape of the banks has been controlled principally by constructive conditions, and in many cases these must still be given predominant influence; but, in view of these recent investigations, it is probable that future works of this sort will be somewhat modified.

The Testing of Lubricating Oils.

A NUMBER of devices have been made for testing the lubricating value of different oils for mechanical purposes, most of these being adapted for journal bearings and similar service. A new oil-testing device is described in an article by Dr. Sigmund Kapff in the *Zeitschrift des Vereines deutscher Ingenieure*; it is especially adapted

for investigations with small high-speed spindles, such as are used in many forms of spinning machines, and, on a larger scale, in some forms of wood-working machinery.

The apparatus of Dr. Kapff is made without belting or gearing, the vertical spindle being driven by a small electric motor, at speeds as high as 8,000 revolutions per minute, while any desired pressure can be brought upon the step-bearing on which the spindle rests. Any desired lubricant may be used, and the work due to the friction is indicated at any instant by the amount of current required by the motor. The spindle is entirely surrounded by an oil chamber, and this again is enclosed in a jacketed cylinder which prevents the escape of heat, while a thermometer is inserted so as to indicate the rise in the temperature of the bearing for any known conditions.

With such an apparatus many properties of lubricating oils which are not readily indicated by other testing devices can be determined. Many oils which show excellent results at moderate speeds begin to work badly at 3,000 revolutions, and at higher speeds the lubricant appears to be thrown entirely away from the bearing, and a greatly-increased frictional resistance appears.

By plotting the quantities of power consumed as ordinates, and the velocities as abscissas, curves may be constructed for various oils; Dr. Kapff gives a number of such curves, with comments upon the behaviour of the lubricants. As might be expected, the higher speeds require oils of greater viscosity than is needed for lower speeds, but this is correct only within certain limits. By taking successive mixtures of petroleum and spindle oil, so as to produce a progression in viscosity, it is shown that beyond a certain point an increase in viscosity requires an increase of work to overcome the friction. The minimum resistance appears with a mixture of 12 parts of petroleum to 88 of spindle oil, and at 4,100 revolutions per minute the gradual diminution in resistance from the successive changes in percentages is shown by the diagram to cease at the above pro-

portion, the curve then taking an abrupt upward turn, showing the increase in resistance as a pure spindle oil is reached.

The paper contains many interesting details concerning the machine and the method of testing, and with machinery involving the use of high-speed spindles there is no doubt that much advantage would accrue from a systematic testing of the oils.

It is undoubtedly poor economy to save a large percentage in the cost of a small quantity of lubricant and add a material proportion to the friction and fuel account, and, since, in connection with this, there is a possibility of material injury to the working parts of valuable and delicate machinery, the cost of careful testing may pay for itself many times over.

The Determination of Moisture in Steam.

WITH the increasing attention being given to the performance of engines and boilers, the quality of steam supplied by the one and used by the other has received its due share of consideration. The evaporative performance of a boiler cannot be compared with that of any other boiler, unless the percentage of entrained water in each case is accurately known; any test of the quantity of steam required per horse power by an engine must include also a knowledge of the quality of the steam thus used.

Various methods and instruments have been devised for determining the quality of the steam, but many of these are described only in passing publications or buried in the transactions of professional societies. The whole subject is now reviewed and discussed in a series of articles by Herr Ernest Brückner, in the *Zeitschrift des Vereines deutscher Ingenieure*, wherein the various devices proposed and used in different countries are described and illustrated.

The earliest experiments in this direction were made by Hirn and his associates, Hallauer and Leloutre, the method used being that of the condensation of the steam in the so-called "continuous" calorimeter. At first rather discordant results were obtained. After further expe-

rience, Hirn stated that the attainable limits for dryness of steam were between 2 and 5 per cent. of moisture. The subject was promptly taken up by Thurston in America and by Unwin in England, and within the past few years much attention has been given to it, especially in the United States, as the *Transactions of the American Society of Mechanical Engineers* show.

After discussing the various causes which may lead to excessive foaming in steam boilers, Herr Brückner proceeds to examine the principles involved in the various methods of determining the quantity of moisture.

The chemical method, in which a known quantity of a suitable salt is dissolved in the water and the proportion of the salt found in the steam measured, is examined, and rejected as lacking in precision.

Before entering upon the discussion of mechanical methods, the conditions attending the formation of watery vapor in steam are examined, and the influence of surfaces of contact and small apertures is taken into consideration. The thermodynamics of an expanding jet is then taken up, and also the construction of mechanical separators, after which the well-known calorimeters of Barrus, Peabody, Carpenter, and others are illustrated, their application being shown. The manner of distribution of moisture in steam pipes is also considered, and the proper method of tapping the connections to the instrument is shown, so that a representative sample of steam may be examined, and the importance of this and similar details of observation is shown.

In summing up, Herr Brückner concludes:

(1) In any test of a steam plant an investigation of the quality of steam must be made, if reliable and satisfactory knowledge of the efficiency is to be gained.

(2) In determining the presence of moisture in steam great care must be taken to make the test while the plant is working in normal condition. The boiler should be fed with clean water, and anything which might cause foaming should be avoided; valves should be opened slowly,

and sudden fluctuations in the use of steam as well as sudden changes in boiler pressure, should be avoided. Also care should be taken that even firing is secured.

(3) The value of the existing methods of determining moisture varies. Chemical methods are not to be recommended, and steam separators give results which, while fairly reliable, are not sufficiently precise for scientific purposes. The condensing calorimeter is also unreliable, even when the greatest care is exercised, and if it is used, the continuous form is to be preferred. Either the superheating or the throttling calorimeter is to be recommended for accurate work, but care should be taken to have high-grade thermometers and accurate pressure gauges, and the various sources of error should be thoroughly investigated and the necessary corrections computed.

The examination of the entire subject in Herr Brückner's paper is well worthy of perusal and many of the points made by him are eminently practical, and the discussion which he gives should have the result of attracting renewed attention to this very important feature in the testing of steam plants.

Progress in the Study of Steel.

THE term steel has always been more or less indefinite in meaning, so that it is generally considered necessary to add some qualifying adjective, in order that the nature of the material under consideration may be understood. Within recent years, however, the causes of the differences between various kinds of steel have been studied in a manner which has enabled metallurgists to speak with some degree of precision concerning them.

An interesting paper upon the progress made in the knowledge of the constitution and characteristics of steel was presented at the meeting of the Association of Engineers of the Academy at Liège by M. Ad. Greiner, the manager of the Cockerill works at Seraing, and has been published in the *Revue Universelle des Mines*.

After referring to the importance of a thorough knowledge of the internal constitution and nature of the metal, M.

Greiner divides the various methods of investigation into three groups:

- (1) Chemical;
- (2) Mechanical;
- (3) Metallographical.

Examination by the chemical method involves two difficulties which may lead to error,—one the difficulty of securing a representative specimen for analysis, the other the difficulty of obtaining a sufficiently accurate analysis within the limits of time and cost imposed by manufacturing and commercial conditions. At the Stockholm congress in September, 1897, efforts were made to have a central laboratory established in connection with the Polytechnic School at Zurich; although the plan met with some opposition, and has not yet been entirely carried out, there is every prospect that such a central laboratory will soon be established.

The method by mechanical test is the one which has been longest in use, and much valuable information has been gained by it. The greatest difficulty with it has been the lack of uniformity in methods and records.

It was to obviate this difficulty that the International Association for testing materials was organized, whose work, at and between the four triennial congresses thus far held, has been devoted to this end. It is not intended to limit the work of various investigators to narrow or irksome rules, but rather to indicate such uniformity in the preparation of test pieces and methods of observing and recording tests as to make the work of students all over the world comparable, and thus render every observation a contribution to the general advance of the science.

By far the most rapid advance has been made, however, in the comparatively new method of metallography, which includes the examination, microscopical or otherwise, of the physical structure of the metal, the study generally being aided by etching the surface, in order to bring out the configurations more clearly.

By the use of the method of metallography many perplexing points in connection with the behaviour of steel and other metals have been either explained or indi-

cated. In one case, noted by M. Ast, two sets of rails placed in the same line of track, passed over by the same trains under the same conditions, showed marked difference in wear, although under mechanical and chemical tests they seemed to be composed of precisely the same material. It was only by treatment with acid, and a microscopical examination, that a marked structural difference in the steel of the two sets of rails was revealed. A simpler and more convincing proof of the value of metallography could hardly be cited.

It is this question of structural change which is leading to some knowledge of the actions that take place in the operations of hardening and tempering, and there is every prospect that these important processes will be entirely removed from their present empirical position, definite scientific knowledge replacing the arbitrary recipes and formulas now cherished as workshop secrets.

One of the most valuable features of metallography lies in the readiness and accuracy with which the results may be recorded by photography, this fact making it especially practicable to compare records made at distant points and long intervals of time. M. Greiner gives a number of illustrations of photo-micrographs of various steels and alloys, which illustrate his points very fully, and at the same time bear witness to the value of photography and photo-engraving in this connection.

Altogether, much of the mystery which has surrounded the structure and behaviour of steel bids fair to be cleared up before these modern methods of investigation, so that greater uniformity in product and greater certainty in use may fairly be predicted for the future.

Test of a Heavy Cable.

TENSION tests of wire cables are by no means rare, and, as a usual thing, attract but small attention; but, when a cable of 90 millimetres diameter (3.6 inches) is submitted to the action of a 500 ton testing machine, the record of the result is interesting, even though the specimen was not actually pulled apart.

The illustrated account of the test is

given by Professor Martens in the *Mitheilungen aus den Königlichen Technischen Versuchsanstalten*, the tests having been made at that institution by Professor Martens himself, in the great machine of his own design.

The cable, which was made by the St. Egid Iron and Steel Company, was composed of six main strands twisted about a core of tarred hemp rope. Each main strand consisted of six secondary strands also twisted about a hemp core, the secondary strands each containing 30 steel wires of 1.46 millimetres (0.0576 inch). There were thus $6 \times 6 \times 30 = 1,080$ wires, with a total cross section of 1,808 square millimetres (2.8 square inches). According to the requirements of the manufacturers, the wire in the cable was to have a breaking strength of 185 kilogrammes per square millimetre (about 260,000 pounds per square inch).

As might well be expected, the principal difficulty in connection with such a test lay in the securing of the cable to the heads of the testing machine so as to prevent slipping, and at the same time avoid crushing or otherwise deforming it to an extent which would interfere with the reliability of the test.

Two methods were adopted, one end of the cable being passed around a heavy cast-iron dead-eye, and the end spliced back into the main cable, while the other end was passed about a similar dead-eye and laid back parallel to the main cable, three sets of iron clamps being used to hold the two together. The clamps were channelled out to receive the cable and hold it without crushing, and it was expected that the three sets of clamps would be capable of holding against any pull necessary for the test.

Much trouble was experienced with these clamps, as the dead-eye turned in the cable, owing to the slipping of the clamped portions, and rendered several trials necessary. Finally, under a total tension of 250,000 kilogrammes (550,000 pounds), a number of the wires in the main body of the cable broke, and at the same time two of the main strands at the throat of the splice parted. Observations

made of the dimensions of the cable as the tension was increased showed a gradual diminution in diameter, the reduction being from 92 millimetres at the start to 80 millimetres under a tension of 150,000 kilogrammes.

Dividing the total breaking load by the actual cross-section of wire in the cable, we have a breaking strength of 138 kilogrammes per square millimetre (about 196,000 pounds per square inch), or about 75 per cent. of the required test strength of the single wires.

The article shows photographic reproductions of the cable in the testing machine, and these add much to the interest of the account. Altogether, the results form a remarkably good showing, especially for a cable of such dimensions; and both the cable itself, and the machine in which it was tested, are noteworthy contributions of Germany to industrial products.

Heavy Automobile Vehicles.

THE general idea of an automobile is that of a pleasure carriage, such as a motor tricycle, and the principal efforts of designers have been directed to the production of a vehicle either for private use or possibly for city cab service.

The results of the trials of the so-called "poids-lourdes" in France have been to direct attention to the possibilities of these heavy road motor vehicles, and the success which has attended them, especially in France, may lead to their adoption elsewhere, as soon as local official prejudice can be overcome.

Among the best known of the general road automobiles those constructed on the Scotte system are included, and the fact that a regular omnibus service has been maintained between Courbevoie and Colombes for more than a year is evidence of the practical nature of these vehicles.

A full description of them is given in a recent issue of *La Revue Technique*, with plates showing the construction in detail. There is nothing particularly novel in the design, the Scotte automobile being simply a well-planned steam omnibus for

use on thoroughly good roads, and the success of the machine is owing rather to the general good judgment which has been displayed in adapting steam for the service than to the display of any especial inventive ability.

Steam is furnished by a vertical boiler of the Field type, not unlike some which have been used for steam fire engine purposes, a special form of hood being arranged to prevent cinders and sparks from being discharged in an offensive manner. The engines are placed beside the boiler, there being two vertical cylinders, and the motion being transmitted by double chain gearing to the drivers.

One chain transmission connects to an intermediate shaft, from which independent chains and sprocket wheels transmit the motion to the drivers. A "jack-in-the-box" gearing system is contained in the hub of each driving-wheel, enabling change of speed to be obtained, and the connections are so arranged that the speed can be varied for both wheels simultaneously, or for either independently, thus giving special facility of control for curves of short radius.

The steering is effected by turning the wheels of the rear axle each on its own swivel, the two being coupled by rods to a screw operated through bevel gears and shaft, by a convenient hand wheel.

Although there are a number of seats in the motor vehicle, the Scotte system includes the hauling of a trailer omnibus, and in some instances of a merchandise wagon, the whole forming a train capable of moving on ordinary highways at a speed of six to seven miles an hour. It is not intended to offer inducements for pleasure travel, the system being designed expressly to enable many parts of the country now out of convenient reach of railway communication to be placed in connection with cities and commercial centres and given facilities which otherwise they would not possess.

The principal criticisms to be made on the system are the low limit of speed and the large combustion of fuel. The latter doubtless will be reduced with improved engines, but the former is governed rather

by the conditions of the roads, and the general necessities of the case, than by any features of construction of the machine.

Such a system may be of service in France, but it is hardly likely to come into vogue either in England or America. In the United States the rapidly-extending use of trolley electric tramways as feeders to the main railway stations has shown an acceptable and convenient method of solving the problem of putting the outlying country districts into communication with the commercial centres, and the same will doubtless come into use in England, as occasion may demand, rather than any system of slow steam trains on common roads.

The Heat Balance of the Blast Furnace.

WHEN we consider the apparent simplicity of the operations performed in an ordinary blast furnace, it seems as if the chemical and thermal reactions involved should long ago have been fully understood and recorded. As a matter of fact, however, metallurgists are by no means united as to the exact conditions which obtain, when, by the action of heat and blast, a mixture of coke, ore, and flux is converted into metallic iron, slag, and gas; and on many points the authorities still agree to disagree.

A very thorough discussion of the subject, by M. G. Rocour, appears in the *Revue Universelle des Mines*. The paper was presented among the technical discussions at the semi-centenary of the Association of Engineers of the Mining Academy of Liège, and in it the views of the most prominent writers are compared and reviewed.

The chemical side of the process is fairly well settled, and M. Rocour devotes himself mainly to an analysis of the thermal reactions and to an effort to establish the heat balance which must exist during the operations of smelting. After a brief review of the theories of Tunner, Lowthian Bell, Gruner, Ledebur, and others, M. Rocour refers to the important relation which the thermo-chemical researches of Thomsen, Berthelot, and Mahler bear to the

subject, in that they enable the calorific value of the various materials under discussion to be determined and the heat exchanges computed. The data for these researches he has gathered from various sources. Some very complete records were obtained from the Jarville furnaces, in Belgium; others from furnaces in the Cleveland district, by Bell; and still others from furnaces in the Saar district, by Jung, Thielen, and Schinz. Data are also given for the Lucy furnace at Pittsburg.

By computing the total quantity of heat furnished, in calories, from the fuel and in the hot blast, and balancing against this the number of calories required to accomplish the reactions produced in the reduction of the iron, the thermal efficiency of the furnace can be calculated, thus enabling the economic performances of various furnaces to be compared on a thermal basis.

This M. Rocour has done in a number of cases, and his paper contains numerous examples fully worked out in detail, in such a manner as to enable any intelligent reader to apply the method to other cases. The efficiencies of the furnaces tabulated in the paper range from 52 to 66 per cent., including heat utilised by the blast.

The thermal exchanges occurring in the different zones of the furnace are also discussed, and graphical diagrams are given, deduced mainly from the observations of Schinz, examined by the methods of M. Rocour; and the subject of the possible methods of obtaining the greatest amount of energy from the discharge gases is examined in connection with the composition of the gas products under different conditions of furnace performance.

While there are other considerations than those of the highest thermal efficiency which must be considered in making up the commercial efficiency of a blast furnace,—the quality of product, the relation of output to fixed charges, and similar points having always to be considered,—from a metallurgical point of view the thermal analysis which M. Rocour has given in this important paper will be found most interesting, and its relation to the general economical performance is undoubted.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, in the original language, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of \$1.35. In ordering, care should be taken to give the number of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices;—15c. each, or fifteen for \$2, forty for \$5, and one hundred for \$12.

Each coupon will be received by us in payment for any 15-cent article catalogued in "The Engineering Index" of THE ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be received for each 15 cents: thus, a 30-cent article will require two coupons; a 45-cent article, three coupons; and so on. With a supply of these coupons on hand no letter writing is required. Simply fill in the number of the article and your address, and mail the coupon to us.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

- | | |
|--|---|
| American Architect. <i>w.</i> Boston, Mass. | Bulletin de la Société d'Encouragement. <i>m.</i> Paris. |
| American Electrician. <i>m.</i> New York. | Bulletin of Dept. of Labor. <i>b-m.</i> Washington, D. C. |
| Am. Engineer and Railroad Journal. <i>m.</i> New York. | Bulletin of the Univ. of Wisconsin, Madison, Wis. |
| American Gas Light Journal. <i>w.</i> New York. | California Architect. <i>m.</i> San Francisco, Cal. |
| American Geologist. <i>m.</i> Minneapolis, Minn. | Canadian Architect. <i>m.</i> Toronto, Ont. |
| American Journal of Science. <i>m.</i> New Haven, Conn. | Canadian Electrical News. <i>m.</i> Toronto, Ont. |
| American Journal of Sociology. <i>b-m.</i> Chicago, Ill. | Canadian Engineer. <i>m.</i> Montreal, P. Q. |
| American Machinist. <i>w.</i> New York. | Canadian Mining Review. <i>m.</i> Ottawa, Ont. |
| Am. Manufacturer and Iron World. <i>w.</i> Pittsburg, Pa. | Century Magazine. <i>m.</i> New York. |
| American Shipbuilder. <i>w.</i> New York. | Chautauquan. <i>m.</i> Meadville, Pa. |
| Am. Soc. of Irrigation Engineers. <i>qr.</i> Denver, Col. | Chem. Met. Soc. of S. Africa. <i>m.</i> Johannesburg, S.A.R. |
| Annals of Am. Acad. of Pol. and Soc. Sci. <i>b-m.</i> Phila., Pa. | Colliery Guardian. <i>w.</i> London. |
| Annales des Ponts et Chaussées. <i>m.</i> Paris. | Compressed Air. <i>m.</i> New York. |
| Architect. <i>w.</i> London. | Comptes Rendus de l'Acad. des Sciences. <i>w.</i> Paris. |
| Architectural Record. <i>q.</i> New York. | Consular Reports. <i>m.</i> Washington, D. C. |
| Architectural Review. <i>s-q.</i> Boston, Mass. | Contemporary Review. <i>m.</i> London |
| Architecture and Building. <i>w.</i> New York. | Cosmopolitan. <i>m.</i> Irvington, N. Y. |
| Architektonische Rundschau. <i>m.</i> Stuttgart. | Deutsche Bauzeitung. <i>b-w.</i> Berlin. |
| Atlantic Monthly. <i>m.</i> New York. | Dingler's Polytechnisches Journal. <i>w.</i> Stuttgart. |
| Australian Mining Standard. <i>w.</i> Sydney. | Domestic Engineering. <i>m.</i> Chicago, Ill. |
| Automotor and Horseless Vehicle Journal. <i>m.</i> London | Eclairage Electrique. <i>w.</i> Paris. |
| Bankers' Magazine. <i>m.</i> New York. | Electrical Engineer. <i>w.</i> London. |
| Bankers' Magazine. <i>m.</i> London. | Electrical Engineer. <i>w.</i> New York |
| Bankers' Magazine of Australia. <i>m.</i> Melbourne. | Electrical Engineering. <i>m.</i> Chicago, Ill. |
| Berg- und Hüttenmännische Zeitung. <i>w.</i> Berlin. | Electrical Review. <i>w.</i> London. |
| Board of Trade Journal. <i>m.</i> London. | Electrical Review. <i>w.</i> New York. |
| Boston Journal of Commerce. <i>w.</i> Boston, Mass. | Electrical World. <i>w.</i> New York. |
| Bradstreet's. <i>w.</i> New York. | Electrician. <i>w.</i> London. |
| Brick Builder. <i>m.</i> Boston, Mass. | Electricien. <i>w.</i> Paris. |
| British Architect. <i>w.</i> London. | Electricity. <i>w.</i> London. |
| Builder. <i>w.</i> London. | Electricity. <i>w.</i> New York. |
| Bulletin Am. Iron and Steel Asso. <i>w.</i> Phila., Pa. | Elektrochemische Rundschau. <i>b-m.</i> Frankfurt. |
| Bulletin of Bureau of Am Republics. <i>m.</i> Washington. | Elektrochemische Zeitschrift. <i>m.</i> Berlin. |
| | Elektrotechnisches Echo. <i>w.</i> Magdeburg. |
| | Elektrotechniker. <i>b-m.</i> Vienna. |

- Elektrotechnischer Anzeiger. *s-w*. Berlin.
 Elektrotechnische Zeitschrift. *w*. Berlin.
 Engineer. *w*. London.
 Engineer. *s-m*. New York.
 Engineers' Gazette. *m*. London.
 Engineering. *w*. London.
 Engineering Assn. of the South. Nashville, Tenn.
 Engineering and Mining Journal. *w*. New York
 Engineering Journal. *s-an*. Stanford Univ., Cal.
 Engineering Magazine. *m*. New York & London.
 Engineering News. *w*. New York
 Engineering Record. *w*. New York
 Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
 Eng. Soc. of Western Penn'a. *m*. Pittsburg, Pa.
 Fire and Water. *w*. New York.
 Forester. *m*. Washington, D. C.
 Forum. *m*. New York.
 Foundry. *m*. Detroit, Mich.
 Gas Engineers' Mag. *m*. Birmingham, England.
 Gas World. *w*. London.
 Génie Civil. *w*. Paris.
 Gesundheits-Ingenieur. *s-m*. München.
 Glasers Ann. f. Gewerbe & Bauwesen. *s-m*. Berlin.
 Gunton's Magazine. *m*. New York.
 Harper's Weekly. *w*. New York.
 Heating and Ventilation. *m*. New York.
 Ill. Carpenter and Builder. *w*. London.
 India Rubber World. *m*. New York.
 Indian and Eastern Engineer. *w*. Calcutta.
 Indian Engineering. *w*. Calcutta.
 Industries and Iron. *w*. London.
 Inland Architect. *m*. Chicago, Ill.
 Iron Age. *w*. New York.
 Iron and Coal Trades' Review. *w*. London.
 Iron & Steel Trades' Journal. *w*. London.
 Iron Trade Review. *w*. Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr*. Wash, D. C.
 Journal Assn. Eng. Societies. *m*. Phila., Pa.
 Journal of Electricity. *m*. San Francisco, Cal.
 Journal Franklin Institute. *m*. Phila., Pa.
 Journal of Gas Lighting. *w*. London.
 Jour. N. E. Waterw. Assoc. *q*. New London, Conn.
 Journal Political Economy. *q*. Chicago, Ill.
 Journal Royal Inst. of Brit. Arch. *s-q*. London.
 Journal of the Society of Arts. *w*. London.
 Journal of U. S. Artillery. *b-m*. Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m*. Chicago, Ill.
 Kansas University Quarterly. *qr*. Lawrence, Kan.
 Locomotive. *m*. Hartford, Conn.
 Locomotive Engineering. *m*. New York
 Locomotive Firemen's Mag. *m*. Peoria, Ill.
 Machinery. *m*. London.
 Machinery. *m*. New York.
 Manufacturer's Record. *w*. Baltimore, Md.
 Marine Engineer. *m*. London.
 Marine Engineering. *m*. New York.
 Master Steam Fitter. *m*. Chicago, Ill.
 Mechanical World. *w*. London.
 McClure's Magazine. *m*. New York.
 Metal Worker. *w*. New York.
 Mines and Minerals. *m*. Scranton, Pa.
 Mining and Sel. Press. *w*. San Francisco, Cal.
 Mining Industry and Review. *w*. Denver, Col.
 Mining Journal. *w*. London.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m*. Vienna.
 Monatsschrift des Württ. Vereines für Baukunde.
 10 parts yearly. Stuttgart.
 Moniteur des Architectes. *m*. Paris.
 Moniteur Industriel. *w*. Paris.
 Municipal Affairs. *qr*. New York.
 Municipal Engineering. *m*. Indianapolis, Ind.
 National Builder. *m*. Chicago, Ill.
 Nature. *w*. London.
 Nature. *w*. Paris.
 New Zealand Mines Record. *m*. Wellington, N. Z.
 Nineteenth Century. *m*. London.
 North American Review. *m*. New York
 Oest. Monatschr. f. d. Oeff. Baudienst. *m*. Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w*. Vienna.
 Physical Review. *b-m*. New York.
 Plumber and Decorator. *m*. London.
 Popular Science Monthly. *m*. New York.
 Power. *m*. New York.
 Practical Engineer. *w*. London.
 Pro. Am. Soc. Civil Engineers. *m*. New York.
 Proceedings Engineer's Club. *q*. Phila., Pa.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr*. La Fayette, Ind.
 Progressive Age. *s-m*. New York.
 Railroad Car Journal. *m*. New York.
 Railroad Gazette. *w*. New York.
 Railway Age. *w*. Chicago, Ill.
 Railway Magazine. *m*. New York.
 Railway Master Mechanic. *m*. Chicago, Ill.
 Railway & Engineering Review. *w*. Chicago, Ill.
 Railway World. *m*. London.
 Review of Reviews. *m*. New York.
 Revue de Mécanique. *m*. Paris.
 Revue Technique. *b-m*. Paris.
 Revue Universelle des Mines. *m*. Liège.
 Sanitarian. *m*. Brooklyn, N. Y.
 Sanitary Plumber. *s-m*. New York.
 Sanitary Record. *m*. London.
 School of Mines Quarterly. New York.
 Schweizerisches Bauzeitung. *w*. Zurich.
 Science. *w*. Lancaster, Pa.
 Scientific American. *w*. New York
 Scientific Am. Supplement. *w*. New York.
 Scientific Machinist. *s-m*. Cleveland, Ohio.
 Scribner's Magazine. *m*. New York
 Seaboard. *w*. New York.
 Sibley Journal of Eng. *m*. Ithaca, N. Y.
 Southern Architect. *m*. Atlanta, Ga.
 Stahl und Eisen. *s-m*. Dusseldorf.
 State's Duty. *m*. St. Louis, Mo.
 Steamship. *m*. Leith, Scotland.
 Stevens' Indicator. *qr*. Hoboken, N. J.
 Stone. *m*. Chicago, Ill.
 Street Railway Journal. *m*. New York.
 Street Railway Review. *m*. Chicago, Ill.
 Technology Quarterly. Boston, Mass.
 Technograph. *yr*. Champaign, Ill.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
 Trans. Am. Ins. Electrical Eng. *m*. New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. Civil Engineers. *m*. New York
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w*. London.
 Western Electrician. *w*. Chicago, Ill.
 Western Railway Club. Pro. Chicago, Ill.
 Wiener Bauindustrie Zeitung. *w*. Vienna.
 Wisconsin Engineer. *qr*. Madison, Wis.
 Yale Scientific Monthly. *m*. New Haven, Conn.
 Year Book of Soc. of Eng. Univ. of Minn.
 Zeitschrift für Lokomotivführer. *m*. Hannover.
 Zeitschrift f. Maschinenbau & Schlosserei. *m*. Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w*. Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w*. Berlin.
 Zeitschrift für Elektrochemie. *s-m*. Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m*. Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Apartments.

Architecture of Apartment Buildings. Irving K. Pond. Presents various types for comparison and for contrast, discussing arrangement and conditions. Plans. 2400 w. Br Build—June, 1898. Serial. 1st part. No. 21222 C.

Balcony.

A Monolithic Concrete Cantilever Balcony. Illustrates a balcony of concrete and twisted iron, projecting 4 ft. and carrying a uniform load of 400 lbs. per sq. ft. 500 w. Eng Rec—June 18, 1898. No. 20939.

Bristol, Eng.

The Ancient City of Bristol, England. Arthur Lee. Illustrated description of many of the ancient buildings. 1500 w. Stone—June, 1898. No. 21214 C.

Cement Construction.

The Record Storage Building of the Discount Bank of Paris, at Rueil. (Les Archives du Comptoir d'Escompte de Paris à Rueil.) Illustrated description of an interesting storage building in cement and steel construction, especially arranged for the storage of papers and documents. 1000 w. La Revue Technique—May 10, 1898. No. 21010 D.

Exposition.

Review of the Works of the Exposition. (Revue des Travaux de l'Exposition.) An excellent illustrated description of the present condition of the work upon the buildings for the exposition of 1900, devoted to the buildings in the Champs Elysées. 4000 w. Le Génie Civil—May 28, June 4, 1898. Two articles. No. 21004 each D.

Fireproofing.

Fireproof Construction. A. L. A. Himmelwright. Reprint from the *The Polytechnic*. Considers particularly the fireproof floor construction, and the protection of the steel skeleton frame of buildings. 3000 w. Arch & Build—May 28, 1898. No. 20532.

The Buck Building, New York City. Illustrates a very narrow tall building for light manufacturing having unusual features in the foundations and columns. 700 w. Eng Rec—June 25, 1898. No. 21165.

Foundations.

A Brick and Iron Foundation for a German Building. Describes a spread foundation for a soil carrying but 3200 pounds per square foot. 600 w. Eng Rec—June 4, 1898. No. 20649.

Exchange Court Building, New York City. Describes and illustrates the pile and cantilever foundations of a 12-story office building. 500 w. Eng Rec—June 11, 1898. No. 20806.

Foundations as Applied to London Buildings and Riverside Foundations. A. T. Walmisley. Read at meeting of the Architectural Assn., London. Observations on the subsoil of London, with particulars from named localities, and the systems in use. Discussion. Ill. 16000 w. Builder—May 28, 1898. No. 20703 A.

Foundations of the Franklin Building. Illustrated description of unusual concrete and steel grillages. 500 w. Eng Rec—May 28, 1898. No. 20543.

Substructures of Tall Buildings.—A Review of Recent Developments and Typical Features. Frank W. Skinner. Emphasizes the need of thorough exploration of the soil below the site, and briefly describes methods used in recent high buildings. Ill. 4500 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21130 D.

Hospital.

The Bettina Pavilion in the Elizabeth Hospital at Vienna. (Der Bettina-Stiftungs Pavillon im k. k. Elisabeth-Spital in Wien.) Plans, elevations and description of the handsome hospital pavilion founded by Baron Rothschild in memory of his deceased wife. 4500 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—June, 1898. No. 21057 D.

House Planning.

Suggestions on House Planning. Grant Holliwell. Read before the Toronto Chapter of Architects. Gives analysis of a plan in its general aspect, and in the details of separate rooms, with examples and remarks. 3000 w. Can Arch—June, 1898. No. 20984 C.

Libraries.

The Libraries of the Middle Ages. T. G. Jackson. Describes the libraries of the middle ages, comparing them with those of the present day. Illustrations and discussion. 13600 w. Jour Roy Inst of Brit Archts—May 21, 1898. No. 20952 B.

Masonry.

Pueblo Masonry. Cosmos Mindeleff, in the Sixteenth Annual Report of the Bureau of American Ethnology. Describes the methods of construction. 1100 w. Stone—June, 1898. No. 21215 C.

Museum.

The New Galleries of the Museum of Natural History, at Paris. (Les Nouvelles Galeries du Muséum d'Histoire Naturelle, à Paris.) With exterior and interior views, also plans and elevation of the fine buildings for the Paris Zoological Museum. 2500 w. 1 plate. Le Génie Civil—May 21, 1898. No. 21001 D.

Reconstruction.

Removing the Pier of a 250-Ton Column. Illustrates a method of replacing masonry by steel to gain cellar space. 700 w. Eng Rec—May 28, 1898. No. 20554.

Steel Framing.

The Steel Frame of the St. Louis Coliseum. E. W. Stern. The remarks are confined to the ironwork of the structure. Gives a general description, with details of construction, illustrations and diagrams. 3000 w. Jour Assn of Engng Soc's—May, 1898. No. 20981 C.

Underpinning.

Developments of Architectural Construction. Illustrated description of methods of underpin-

ning heavy party walls. 2700 w. Eng Rec—June 4, 1898. Serial. 1st part. No. 20650.

HEATING AND VENTILATION.

Carbonic Acid.

Causes of Uncertainty in the Testing for Carbonic Acid in Large Volumes of Air. (Sur Quelques Causes d'Incertitude dans le Dosage de l'Acide Carbonique dans de Grands Volumes d'Air.) A paper by M. Armand Gautier giving details of methods and results. 3500 w. Comptes Rendus—May 16, 1898. No. 21028 D.

Carbonic Oxid.

Method of Testing the Presence of Carbonic Oxid in Air. (Méthode pour Reconnaître et Doser l'Oxyde de Carbone en Présence des Traces de Gaz Carburés de l'Air.) A paper presented before the French Academy by M. Armand Gautier, showing delicate methods of testing impurities in the atmosphere. 3000 w. Comptes Rendus—May 9, 1898. No. 21025 D.

Car Ventilation.

See Railway Affairs, Equipment.

Church.

A Church Heating and Ventilating System. Illustrates and describes the system adopted for the Presbyterian church at Sixty-second street and Woodland avenue, Chicago, Ill. A special feature is the free circulation of warmed air by means of specially constructed and arranged ventilators, with the aid of small gas heaters placed at the bottom of the ventilating shafts. 1800 w. Met Work—June 25, 1898. No. 21156.

Heating and Ventilation in the George W. South Memorial Memorial Church of the Advocate, Philadelphia. Pa. Brief description of one of the most magnificent churches in the United States, with detail drawings of heating and ventilating plant. The installation is a system of indirect radiation, supplemented by a blower with tempering coils. 1500 w. Heat & Ven—June 15, 1898. No. 20949.

Combination System.

Combined Hot Water and Low Pressure Steam Heating System. (Kombinierte Warmwasser und Niederdruckdampf-Heizung.) F. Eclbo. Radiators in the basement are supplied with hot water from below the water line, those in upper floors by steam. 1200 w. Gesundheits-Ingenieur—May 31, 1898. No. 21069 B.

Drying.

Drying Installations. (Trockenanlagen.) M. Grellert. A general investigation of the various methods of drying, with computations of the quantities of heat required to accomplish given results. 2500 w. Gesundheits-Ingenieur—May 15, 1898. No. 21066 B.

Electric Heating.

Heating by Electricity. (Le Chauffage par l'Electricité.) A theoretical investigation of the thermal and electrical conditions involved in heating by electricity, and a comparison with usual sources of heat, as regards cost. 2000 w. La Revue Technique—June 10, 1898. No. 21024 D.

Formulas.

German Formulas and Tables for Heating and Ventilating Work. J. H. Kinealy. The first of a series of articles containing information translated from the German, principally relating to the determination of the radiation surface required by different systems of heating to supply the heat lost through walls of different kinds. 1100 w. Met Work—June 18, 1898. No. 20868.

Grates.

English Fire Grates. Frederick Dye. Information upon the English methods of construction. Ill. 1500 w. Heat & Ven—June 15, 1898. Serial. 1st part. No. 20950.

Heating Plant.

The Heating Plant of the Verity Plow Company, Brantford, Ont. Description and drawings of the heating and power plant being installed in the new works of this company. 1700 w. Ir Age—June 16, 1898. No. 20856.

Hot-Water.

High-Pressure Hot-Water Heating. Frederick R. Farrow. Review of a paper describing characteristic British practice. 800 w. Eng Rec—June 18, 1898. No. 20941.

Post-Office.

Ventilation of the Omaha Post-Office. Illustrated description of the design and construction of an elaborate job. 1700 w. Eng Rec—June 4, 1898. No. 20652.

Prison.

Engineering Features of the Philadelphia City Prison. Illustrated description of the plumbing, ventilation and heating of a prison for 600 inmates. 2000 w. Eng Rec—June 18, 1898. No. 20940.

Public Buildings.

The Warming of Public Buildings. Frederic R. Farrow. A lecture delivered before the Sheffield Society of Architects and Surveyors. Considers hot air heating, hot water, low and high pressures, steam, &c. 8000 w. Jour of Roy Inst of Brit Archts—May 7, 1898. No. 20754 B.

Steam Plant.

Distributing Steam for a Michigan Hospital. Part first describes the large steam plant and heating conduits in the Newberry hospital, where there are 11 detached buildings to receive steam and hot water. Ill. 2200 w. Eng Rec—June 25, 1898. Serial. 1st part. No. 21166.

PLUMBING AND GASFITTING.

Australia.

Plumbing in Australia. Dewdney Ellis. A general description of the conditions of the plumbing trade, with illustrations of devices in common use. 2000 w. Dom Engng—June, 1898. No. 20982 C.

Baths.

The Yonkers, N. Y., Public Bath. Illustrated description of a bath with 22 showers, 2 tubs and two toilet rooms. 700 w. Eng Rec—May 28, 1898. No. 20545.

Club House.

Plumbing in the University Club, New York City. Illustrated description of elaborate work in an 8-story 160 x 140 ft. club house. Part first deals with the general water-supply system. 1600 w. Eng Rec—June 11, 1898. Serial. 1st part. No. 20807.

Country Houses.

Sanitation of Country Houses, Villages, and Small Areas. Edward Tidman. Considers the general principles to be adopted, describing the essential points of the drainage, outfall, &c. 2500 w. San Rec—June 10, 1898. No. 20924 A.

Piping.

Notes on the Discharge Piping of Houses. (Vortrag über Hausentwässerungsleitungen.) An address by building inspector Olshausen of Hamburg, upon the best arrangement of discharge pipes for the connection of various portions of buildings with the sewer. 3500 w. Gesundheits-Ingenieur—May 15, 1898. No. 21067 B.

MISCELLANY.**Architectural Manuscripts.**

Art and Architecture in the Castle Howard Manuscripts. Extracts relating to men famous in art and architecture are given. 3000 w. Builder—June 4, 1898. No. 20821 A.

Australia.

Architectural Progress in Australia. Information from advance proof of an article in the "Year Book of Australia," concerning the building progress in these colonies. 3300 w. Arch, Lond—May 20, 1898. No. 20573 A.

Building Stones.

Quarrying and Finishing Building Stones. W. H. Nichols. Describes the equipment and method of operation in quarrying and working. Ill. 1900 w. Eng & Min Jour—June 11, 1898. No. 20778.

Columns.

See Civil Engineering, Miscellany.

Competition.

Regulating Competition—Methods of Esti-

ating. F. E. Kidder. Calls attention to the evils arising from the bidding below a living profit, and discusses some methods of prevention. 1000 w. Br Build—June, 1898. Serial. 1st part. No. 21225 C.

Gardens.

The Château Gardens of André Le Nôtre. Elizabeth W. Champney. An explanation of the work of this great landscape-gardener, with illustrations and description. 2200 w. Arch Rev, Vol. II, No. IV. Serial. 1st part. 20882 F.

Moving Buildings.

Moving a Railroad Building at Frodsham, England. Describes the moving of a brick structure at a cost of five cents per cu. ft. 1200 w. Eng Rec—June 11, 1898. No. 20804.

Ornamental Iron.

Architectural Wrought Iron Ornament. W. Martin Aiken. A very highly illustrated article describing the growth of ornamental wrought iron work in architectural decoration. 3500 w. Engineering Magazine—July, 1898. No. 21239 B.

Terra-Cotta.

Note on Terra Cotta for Exterior Polychrome Decoration. Elmer Ellsworth Garnsey. Urging the study of color for exterior and interior decoration, and the possibilities of terra-cotta as a material in the façades of large buildings. 3500 w. Br Build—June, 1898. No. 21223 C.

Timber Tests.

See Civil Engineering, Miscellany.

Valuing.

Bases of Value. W. B. Woodhead. A paper read before the Bradford Society of Architects and Surveyors, England. Aims to point out the main principles which should underlie all valuations. 4200 w. Arch't, Lond—June 10, 1898. No. 20969 A.

William Morris.

The Life-Work of William Morris. F. S. Ellis. A review of his artistic and literary career, with recognition of his noble character. Discussion. 10800 w. Jour Soc of Arts—May 27, 1898. No. 20701 A.

CIVIL ENGINEERING.**BRIDGES.****Arches.**

Repairs of Masonry Arch. A. E. Harvey. Describes repairs to stone arches which are quite a departure from the usual practice. Ill. 1500 w. Technograph, No. 12—1897-8. No. 20915 D.

Three-Hinged Masonry Arches, Long Spans Especially Considered. David A. Molitor. The aim of the paper is to demonstrate that masonry arches may be constructed on any good foundation, such as hard clay, and that they will admit of an accuracy and simplicity of design quite equal to that attainable with iron and steel. Ill. 12000 w. Pro Am Soc of Civ Eng—June, 1898. No. 21176 F.

Erection.

Bridge Erection. Frank H. Constant. Discusses some of the most common methods. 3800 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20662 E.

Foundations.

The New York Anchorage of the New East River Bridge. Illustrated description of an unusual plant for concrete work. 2700 w. Eng Rec—June 18, 1898. No. 20934.

Girders.

The Iron Girder Bridges of the Vienna City Railway (Die Eiserne Balkenbrücken der Wiener Stadtbahn.) Sigmund Kulka. With details and photographic view of these fine girders of

spans from 50 to 80 feet. 3500 w. 1 plate. *Zeitschr d Oesterr Ing u Arch Ver*—May 20, 1898. No. 21051 B.

Loading.

Typical Loading for Railway Bridge Specifications. Extract from paper by W. H. Schuerman, read at meeting of the Engng. Assn. of the South. Treats of loading which gives stresses which need only to be multiplied by a factor to give stresses agreeing closely enough for all practical purposes with the stresses produced by any of the specified loadings in general use. 2000 w. *Ry & Engng Rev*—June 18, 1898. No. 20929.

Park Bridge.

Erection of a Fairmount Park Bridge. This bridge has three 200-foot arch spans, erected by falsework and traveler of unusual form. Ill. 800 w. *Eng Rec*—June 4, 1898. No. 20645.

Pittsburg Bridge.

The Panther Hollow Bridge, Pittsburg, Pa. An illustrated description of the design, construction, and erection of a 3-hinged arch of 360-ft. span. 1300 w. *Eng Rec*—June 4, 1898. No. 20644.

Rock Island Bridge.

Erection of the Rock Island Bridge. Illustrated description of method used for an 1830 ft. bridge over the Mississippi, where an old bridge had to be replaced without interrupting trains. 1800 w. *Eng Rec*—May 28, 1898. No. 20536.

Skew Bridges.

A Graphic Method of Setting Out the Face-Angles of Skew Bridge Voussoirs. H. H. Humphreys. Gives an explanation of the method devised by Mr. D. Connery for solving the problem. Ill. 1000 w. *Builder*—June 18, 1898. No. 21201 A.

CANALS, RIVERS AND HARBORS.

Concrete.

Concrete Masonry, Illinois & Mississippi Canal. Gives the rules for building large concrete locks by day labor. 2500 w. *Eng Rec*—May 28, 1898. No. 20537.

Dam.

The Canyon Ferry Dam Theron M. Ripley. Description of this work, with map, illustration, and discussion. 2500 w. *Jour Assn of Engng Soc's*—May, 1898. No. 20979 C.

The Failure of the Lynx Creek Masonry Dam, near Prescott, Arizona. Jas. D. Schuyler. Notes on this disaster with photographs taken on a recent visit. 1200 w. *Eng News*—June 9, 1898. No. 20769.

The Movable Dam on the Big Sandy, River. (Barrage Mobile du Big Sandy.) A French account of this important needle-dam on the Big Sandy River, Kentucky. 3000 w. 1 plate. *Le Génie Civil*—May 14, 1898. No. 21000 D.

Dredging.

Dredges and Dredging on the Mississippi River. J. A. Ockerson. Presents a general view of the physical conditions, showing the problem requires different treatment in different parts of the river, and its general complexity ;

describes some devices for the removal of sand bars and other work, and their operation ; gives illustrated description of numerous dredges and auxiliary machinery, and shows the magnitude of the work undertaken. Ill. 28300 w. *Pro Am Soc of Civ Engs*—June, 1898. No. 21174 F.

Graving Dock.

The New-Graving Dock of the Clyde Navigation Trust. Illustrated description of the Glasgow Dock—No. 3, and its construction. 4000 w. *Engr, Lond*—May 20, 1898. Serial. 1st part. No. 20578 A.

Great Lakes.

Reservoir System of the Great Lakes of the St. Lawrence Basin. Hiram M. Chittenden. Its relation to the problem of improving the navigation of these bodies of water and of their connecting channels. With a mathematical analysis of the influence of reservoirs on stream flow, by James A. Seddon. Diagrams. 17500 w. *Pro Am Soc of Civ Engs*—June, 1898. No. 21175 F.

Harbor Improvement.

Improving the Harbor of Duluth. The reconstruction of the entrance piers for this harbor, and other improvements on the Great Lakes are discussed. 1000 w. *Ir Age*—June 9, 1898. No. 20780.

Lighthouse.

The Prongs Lighthouse. J. H. E. Hart. An illustrated account of a lighthouse built at the entrance of the Bombay harbor. 4800 w. *Engr, Lond*—June 3, 1898. No. 20824 A.

Lock.

Lock Reconstruction on the Oswego Canal. Illustrated description of large concrete locks, with limestone facing. 1100 w. *Eng Rec*—June 25, 1898. No. 21160.

The Lock of the Dortmund-Ems Canal at Henrichenburg. From the *Illustrirte Zeitung*. Illustrated description of a lock that overcomes a difference in level of fifty-nine feet. 500 w. *Sci Am Sup*—June 25, 1898. No. 20996.

Madras.

Madras Harbor. W. B. de Winton. A review of F. J. Wilson's boat basin project, stating objections to the proposals and offering his own views on the subject. 2000 w. *Ind Engng*—May 14, 1898. No. 20819 D.

Mississippi.

The Chronology of the Mississippi System. James L. Greenleaf. Discusses the conditions that influence the chronology of flow, especially the variation in intensity of rainfall and temperature. Map. 2200 w. *Sch of Mines Quar*—April, 1898. No. 20668 D.

Nicaragua.

See Economics and Industry, Commerce and Trade.

IRRIGATION.

Arid Regions.

Experiences in the "Arid Southwest." Solon M. Allis. Describes the physical features of this region, and the difficulties in obtaining the needed water supply, giving personal experiences.

3500 w. Jour of New Eng Water-Works Assn—June, 1898. No. 20907 F.

Turlock District.

A Great Irrigation Enterprise. Some information relating to the Turlock irrigation enterprise in San Joaquin, Cal., valley. Ill. 700 w. Min & Sci Pr—June 18, 1898. No. 21155.

MISCELLANY.

Address.

Address before the Montana Society of Engineers. C. W. Goodale. Reviews some important engineering works in the state that have been executed during 1897. Ill. 5800 w. Jour Assn of Engng Soc's—May, 1898. No. 20978 C.

Beams.

The Efficiency of Built-Up Wooden Beams. Edgar Kidwell. Discussion of this paper which was presented at the Lake Superior meeting, July, 1897. 6300 w. Trans of Am Inst of Min Engs—June, 1898. No. 21136 D.

Cement.

Hydraulic Cements. Clifford Richardson. Discusses the characteristics of the best Portland cement, and its setting, hardening, &c. Also natural cements. 1800 w. Br Build—June, 1898. Serial. 1st part. No. 21224 C.

The Effect of Freezing Cement Mortar. A. C. Hobart. Describes experiments made, giving results which differ from generally accepted ideas. 3000 w. Technograph, No. 12—1897-8. No. 20911 D.

Cement Construction.

See Architecture and Building, Construction.

Cement Testing.

Cement Testing, Metropolitan Water-Works. Reprinted from the Third Annual Report of the Metropolitan Water Board. Describes the methods adopted by F. P. Stearns on the water-works for Boston and vicinity. 1200 w. Eng Rec—May 28, 1898. No. 20538.

Standard Methods of Testing Cement. Rules deduced by Max Gary to prevent variations by changes in manipulation. 700 w. Eng Rec—May 28, 1898. No. 20534.

Testing with the Böhme Hammer Apparatus. (Prüfung der Hammerapparate, Bauart Böhme.) The cement is placed in a mould and struck rapidly by a mechanically operated triphammer, which also records automatically the number and amplitude of its blows. 1800 w. Mitt Aus d Kgl Tech Versuchsanstalt—Part 2, 1898. No. 21071 G.

Columns.

Tests of Full-Sized Cast-Iron Columns. Wm. H. Burr. Table giving results of tests made, also a graphical representation of results, with explanatory notes and comments. 1600 w. Sch of Mines Quar—April, 1898. No. 20667 D.

The Present Status of the Cast-Iron Column. A review of the changes in old methods of computation caused by recent full-size tests. 1100 w. Eng Rec—June 11, 1898. No. 20801.

Concrete.

Placing Concrete in Ninety Feet of Water. Daniel W. Mead. Describes unusual work at

Rockford, Ill. 800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21127 D.

Properties of Concrete Under Compressive Stress. David Molitor. Gives the best available data on this subject, though the number of experiments is rather limited. Ill. 2500 w. Jour Assn of Engng Soc's—May, 1898. No. 20980 C.

Strength of Concrete of Various Proportions. R. B. Ketchum and Fred. W. Honens. A summary of results of a series of experiments made in the Cement Laboratory of the Univ. of Illinois, to determine the variation in strength of concrete due to a difference in the proportion of the ingredients. 600 w. Technograph, No. 12—1897-8. No. 20913 D.

Drainage.

Reclamation of Wet Land in the Red River Valley. W. R. Hoag. An account of the drainage of valuable wheat land in Minnesota, the difficulties met and overcome. 2500 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20660 E.

Expert Testimony.

The Use of Scientific Books by Expert Witnesses. A decision of the U. S. Circuit Court upon the subject of excluding scientific books from the witness stand. 600 w. Eng Rec—June 11, 1898. No. 20800.

Laboratory.

The Great Hydraulic Laboratory at Cornell. Harley S. Gibbs. The important features of its construction, its purposes, and aims. Ill. 2300 w. Trans of Assn of Civ. Engs of Cornell Univ—1898. No. 21131 D.

Piers.

Brick Piers. Results of Tests made in the Laboratory of Cornell University, 1897-8. Ill. 800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21134 D.

Retaining Walls.

A Rational Theory of Retaining Walls. (Rational-Theorie der Stützmauern) R. Iszkowski. A general discussion of the subject of earth pressure in retaining wall design, with tables, formulas and a sheet of diagrams. 3500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—June, 1898. No. 21059 D.

Roads.

The Road Construction System in the Tyrol. (Der Ausbau des Concurrenzstrassennetzes in Tirol.) With map showing the extent to which the official plans have thus far been executed. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—June, 1898. No. 21058 D.

The Roman Highways. D. R. McAnally. Describes these remarkable roads and their construction. 1500 w. Ap Pop Sci M—June, 1898. No. 20638 D.

Surveying.

Description of a Topographical Survey of a Four-Thousand-Acre Tract. Edwin Durvea. A detailed description of a survey in Indiana that needed very accurate maps in order to dispose and arrange many industries. 12800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21132 D.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

China.

American Competition in China. Editorial on the influence of war on trade and industry, and special consideration of the expansion of United States trade in China. 1500 w. Engng—June 3, 1898. No. 20832 A.

Foreign Commerce in China in 1897. Reports the foreign trade for 1896 the largest ever record. d. The year of 1897 is the third best on record. 800 w. Cons Repts, No. 132—June 4, 1898. No. 20635 D.

The Commercial Importance of the Yang-tze. Information concerning the economic condition of the several ports open for trade on this river, taken from the report of F. S. A. Bourne, British consul. 3800 w. Bd of Trd Jour—June, 1898. No. 21208 A.

The First Steamer at Chungking. Some interesting notes on trade in the Yang Tsi Kiang region, with report of the first British steamer that has made its way to this important distributing center. 700 w. Engng—May 27, 1898. No. 20713 A.

Colonies.

Colonies and Chartered Companies. Alfred C. Lyall. An interesting address containing matters of interest relating to trade. Discussion. 10800 w. Jour Soc of Arts—June 3, 1898. No. 20813 A.

United States Trade in North China. Extract from the annual report for 1897, by Mr. Taylor, statistical secretary of customs, Shanghai, with remarks by the U. S. consul, showing that the U. S. interests in this part of China are second to none. 2500 w. Cons Repts. No. 145—June 20, 1898. No. 20951 D.

Consular Services.

On the Utilization of Consular Services in the Interests of British Trade and Commerce. Edward H. Carbutt. Refers to the work of the American Bureau, and offers suggestions with a view to improving the Consular Reports for purposes of British commerce. 3700 w. Ir & Coal Trds Rev—May 20, 1898. No. 20567 A.

Exports.

Exports of Locomotives and Some Other Material. Editorial on the growth of our foreign trade in locomotives, giving interesting statistics, and information. 1300 w. R R Gaz—June 17, 1898. No. 20895.

Foreign Trade.

The Cash System in the Foreign Trade. Emil Maritschek. A discussion of the present system of payment in the American export and import trade, with suggestion for needed improvement. 700 w. Ir Age—June 9, 1898. No. 20779.

France.

British Trade with France. Report of the British consul shows a continuous diminution of demand for British goods. 1800 w. Bd of Trd Jour—June, 1898. No. 21211 A.

Germany.

Germany's Trade with South America. Some information relating to the articles of export, with tables showing the changes that have taken place, and the efforts to be made to conquer the South American market for Germany. 700 w. Cons Repts, No. 126—May 27, 1898. No. 20527 D.

Some Factors in the Industrial Progress of Germany. Editorial on the report of T. R. Mulvany, the British consul at Dusseldorf, on trade in Germany. 2500 w. Engng—May 27, 1898. No. 20711 A.

Great Lakes.

The Carrying Trade of the Great Lakes. Allan Hendricks. Considers the great importance of the commerce of these lakes, the modern type of freight carriers, the projects for enabling the lake steamers to reach the ocean, passenger boats and other craft, and related matters of interest. 4400 w. N Am Rev—June, 1898. No. 20655 D.

Hire-Purchase.

Hire-Purchase Wagon Accounts and Agreements. George Johnson. An explanation of the practice of colliery and manufacturing companies by which they pay for the wagons by equal periodical instalments, with interest. 1600 w. Col Guard—June 10, 1898. Serial. 1st part. No. 20962 A.

Iron Trade.

Shipping Freights and Conferences as Affecting the Iron and Steel Trades. J. Stephen Jeans. Read before the British Iron Trade Assn. A statement of the conditions which seem to be greatly affecting the position and prospects of British trade. 4500 w. Ir & Coal Trds Rev—June 3, 1898. No. 20841 A.

Japan.

The Foreign Trade of Japan for 1897. Calls attention to some of the most important points in the British annual report on foreign trade of Japan. 2200 w. Engng—June 17, 1898. No. 21183 A.

Nicaragua.

National Influence and the Isthmian Canal. Lewis M. Haupt. A discussion of the military and commercial importance to the United States of a canal through the isthmus, and the desirability of having it under the control of the U. S. government. 3500 w. Engineering Magazine—July, 1898. No. 21231 B.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Tabulated statement with comments on prices for May, 1898. 4000 w. Bradstreet's—June 11, 1898. No. 20782.

Siberia.

The Opening of Siberia. Information concerning this extensive and richly endowed region, its mineral riches, industries, and the opening for foreign trade. 2800 w. Bd of Trd Jour—June, 1898. No. 21209 A.

South America.

How to Extend United States Trade in South America. Urging young men to go to this region and learn the language, methods of business, etc. 900 w. Cons Repts, No. 126—May 27, 1898. No. 20528 D.

Syndicates.

The Syndicates in Germany. An account of these combines to better industrial conditions, and the way the business is conducted. 2500 w. Ir Age—June 2, 1898. No. 20619.

Tariff.

Revised Tariff of Values for British India. Schedule of previous and present valuations for the purposes of comparison. 1200 w. Bd of Trd Jour—June, 1898. No. 21212 A.

Tariff Changes and Customs Regulations. Russia, Norway, Sweden, Germany, Belgium, France, Portugal, Spain, Bulgaria, United States, Peru, Ecuador, Persia, Gibraltar, British India, and Victoria. 5500 w. Bd of Trd Jour—June, 1898. No. 21213 A.

Tin Plate.

Decline of British Export Trade: Tin-Plate Industry. Gives two commercial editorials from the Birmingham *Daily Post* dealing with downward tendency of British export trade. Also a paper by John Jenkins read at meeting of British Iron Trade Assn. 8000 w. Cons Repts, No. 140—June 14, 1898. No. 20847 D.

Trade-Marks.

Trade-Marks in Cape Colony. Copy of the trade-marks act, and of rules and regulations relating to registration. 4200 w. Cons Repts, No. 136—June 9, 1898. No. 20734 D.

Trade Methods.

British versus German Trade Methods in Spain. Some of the reasons why German goods are preferred. The importance of securing British travelers acquainted with the Spanish language to look after the interests of trade in Spain. 1500 w. Bd of Trd Jour—June, 1898. No. 21210 A.

Trade Statistics.

Some Contrasts in British and American Trade. Comment on the foreign trade of the respective countries, British trade falling off while American trade is increasing. Some explanation of the trade returns, and how far they are misleading. 900 w. Bradstreet's—June 25, 1898. No. 21167.

CURRENCY AND FINANCE.**Bimetallism.**

Bimetallism and the Silver Producing Industry in the United States. (Le Bimetallisme et l'Industrie de l'Argent aux Etats-Unis.) E. Detienne. An interesting view of the relations between the production of silver and the bimetallic theories, as viewed by a Belgian engineer. 7500 w. 1 plate. Revue Universelle des Mines—May, 1898. No. 21097 H.

Circulation.

The Precious Metals. Jerome Dowd. On the influences which govern their flow from one country to another. 1100 w. Banker's Mag, N. Y.—June, 1898. No. 20902 D.

Currency Reform.

The Currency Reform Bill. Synopsis of the bill for currency reform reported by the House Committee on Banking, May, 1898. 1700 w. Banker's Mag, N. Y.—June, 1898. No. 20903 D.

Gladstone.

Mr. Gladstone as a Financier. Extracts from article in the *Financial Times*, from the standpoint of his achievements when in the position of Chancellor of the Exchequer. 2500 w. Banker's Mag, Lond—June, 1898. No. 20671 B.

LABOR.**Accidents.**

The Law Upon Accidents to Workingmen. (Loi sur les Accidents du Travail.) The full text of the new French law fixing the responsibility for accidents occurring to workingmen during the course of labor. Indemnities for death or disability are based upon the earning capacity of the individual. 3000 w. La Revue Technique—May 25, 1898. No. 21019 D.

American Workmen.

A French View of the American Working-Man. Theodore Stanton. Remarks on the history of "L'Ouvrier Américain" by Emile Levasseur, the most complete work ever written by a foreigner on the subject of the American working-man. 3000 w. Forum—June, 1898. No. 20657 D.

Compensation Act.

The Insurance Companies and Employers. Editorial on the exorbitant premiums demanded, quoting from speech of Joseph Chamberlain before the Birmingham (Eng.) Liberal Unionist Assn. 1800 w. Engr, Lond—June 17, 1898. No. 21188 A.

The Oppressed "Undertakers." Editorial on the Workmen's Compensation Act of 1897, in England, showing the additional burdens placed on employers. 2200 w. Engr, Lond—June 3, 1898. No. 20825 A.

The Workmen's Compensation Act. A communication from Showell Rogers, of Birmingham, to the London *Times*. Discusses the scheme of the act and its defects. 2200 w. Arch't, Lond—June 10, 1898. No. 20970 A.

The Workmen's Compensation Act. An analysis of this act about to come in force in England, by a member of the Junior Bar. 2800 w. Engr, Lond—June 10, 1898. No. 20967 A.

The Workmen's Compensation Act. R. T. Thomson. Deals with the principal features of this important measure in England, pointing out some of the anomalies, and considering the financial aspect from the employers' point of view. 7000 w. Nineteenth Cent—June, 1898. No. 20896 D.

Co-operation.

Co-operative Production. Editorial on Lord Brassey's article in the *Nineteenth Century* for June, and discussing the chief obstacles to the successful development of a co-operative system. 2000 w. Engng—June 10, 1898. No. 20957 A.

The Difficulties and the Limits of Co-operation. Lord Brassey. A review of the progress thus far made in co-operative and profit-sharing

industries. Deals with the attempts of workmen to become their own employers, giving examples and showing that in practice difficulties have in many instances led to failures; that profit-sharing has not been successful, and discusses what could be accomplished by Trades Unions. 8500 w. Nineteenth Cent—June, 1898. No. 20897 D.

Eight-Hour Day.

The Eight-Hour Day on Government Work. Arguments of representatives of the leading iron and steel manufacturers before the U. S. Senate Committee on Education and Labor, protesting against the passage of the pending bill which has already been favorably acted upon by the House. 2800 w. Ir Age—June 23, 1898. No. 20998.

Insurance.

Working-Men's Insurance. Reviews a work recently published by William Franklin Wiloughby, showing the importance of this subject and the way it is regarded in different countries. 1600 w. Builder—May 21, 1898. No. 20574 A.

Japan.

Factory Labor in Japan. Discusses the pro-

posed legislation for factory regulation, giving extracts of interest in connection with the subject. Ill. 2800 w. Ind & East Engr—May, 1898. Serial. 1st part. No. 20845 D.

Labor Conditions.

Textile War between the North and the South. Jerome Dowd. A comparison of wages, cost of living, &c, of the wage-earners in the north and south, with special reference to the textile industries. 2800 w. Forum—June, 1898. No. 20656 D.

Labor Question.

New Lights on the Labor Question. Reviews two articles which have recently appeared in the "Quarterly" and "Edinburgh Reviews," bearing on this subject. 2200 w. Jour Gas Lgt—May 24, 1898. No. 20598 A.

Liability.

Employers and Workmen's Liability Laws. Pasquale Villari. Translated from *Nuova Antologia*. A study of the law and its effects in the countries most obedient to it. 2200 w. Chau—June, 1898. No. 20549 C.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bullion.

Electrolytic Methods of Bullion Refining. John B. C. Kershaw. An account of Dr. Wohlwill's method for refining gold bullion, giving details of the process. The advantages claimed over the older methods, are those of greater economy and convenience. 2300 w. Elect'n, Lond—June 3, 1898. No. 20843 A.

Electrolytic Assay.

See Mining and Metallurgy, Copper.

Electro-Metallurgy.

Progress in Electro-Metallurgy in 1897. E. Andreoli. Reviews the processes in use and the new methods applied to various branches of the industry. 3400 w. Eng & Min Jour—June 18, 1898. No. 20947.

Recent Applications of Electro Chemistry to the Metal Industries. Sherard Cowper-Coles. Describing the modern electro galvanizing methods, also devices for removing mill scale, for the production of parabolic reflectors, and other recent applications of electro chemical methods. 3000 w. Engineering Magazine—July, 1898. No. 21235 B.

The Application of Electricity to Metallurgy on the Large Scale. (Die Rolle der Elektrizität bei der jetzigen Metallgewinnung in Grossen.) Dr. Dürre. A general review of the present state of the art of electrometallurgy, with especial reference to the winning of metals from their ores. 7500 w. Elektrotech Zeitschr—June 2, 1898. No. 21085 B.

Furnace.

Description of Experimental Electric Furnace. (Mitteilung über einen Versuchsofen.) Dr. Borchers. An illustrated description of a convenient form of electric furnace for use in gen-

eral laboratory research. 1200 w. Zeitschr f Elektrochemie—May 20, 1898. No. 21088 H.

Mercury.

The Constitution of Mercury. (Ueber die Konstitution des Quecksilbers.) C. Liebenow. A paper before the Electrochemical Society showing mercury to be composed of molecules of different atomic constitution. 3500 w. Zeitschr f Elektrochemie—May 20, 1898. No. 21087 H.

Ozone.

I. Electrical Production of Ozone. II. Purification and Sterilization of Water by Ozone. The first article is an illustrated description of apparatus devised by Mr. Andreoli, for producing ozone. The second describes the treatment of the water of the river Seine. 2500 w. W Elect'n—May 28, 1898. No. 20552.

Review.

The Industrial Applications of Electro-Chemistry. Thomas Ewan. Briefly reviews the progress in this field since 1792, giving a general description of processes actually employed. 5500 w. Nature—June 2, 1898. No. 20814 A.

Separation.

A Method for the Separation of Cobalt and Nickel. (Eine Methode zur Trennung von Kobalt und Nickel.) Dr. Coehn. A description of the electro-capillary method, using capillary glass electrodes. 1200 w. Zeitschr f Elektrochemie—May 20, 1898. No. 21086 H.

Voltameter.

The Hydrogen Voltameter and its Reliability. (Das Wasserstoff Voltameter und seine Zuverlässigkeit.) H. A. Naber. Reviewing the investigations of Faraday and later physicists, and illustrating and describing a decomposition voltameter for precise work. 1800 w. Elektrochem Zeitschr—June 1, 1898. No. 21089 D.

LIGHTING.**Address.**

Presidential Address ; Chicago National Electric Light Association Convention. Samuel Insull. Discusses standard vs. special machinery, selling price based on cost, public control and private operation, &c. 5000 w. Elec Eng, N. Y.—June 16, 1898. No. 20864.

Heat Compensator.

Improved Heat Compensator for Shunt Arc Lamps. (Verbesserter Wärmekompensator bei Nebenschluss-Bogenlampen.) The Körting and Mathiesen device consists of a compound zinc-iron expansion apparatus connected with the regulator so as to compensate for changes of temperature. 3000 w. Elektrotech Zeitschr—May 19, 1898. No. 21079 B.

Lamp.

New Electric Lamps, and Methods of Production. (Neue Elektrische Lampe und Verfahren zu deren Herstellung.) A description of the new incandescent electric lamp invented by Dr. Karl Auer von Welsbach. 1500 w. Glaser's Annalen—May 15, 1898. No. 21065 D.

Lamp Economy.

Economy of Electric Lamps. G. W. Baird. A discussion of the need of close inspection of the quality of incandescent lamps, reporting tests made. 1600 w. Jour Am Soc of Naval Eng—May, 1898. No. 20682 H.

Lamp Tests.

Important Considerations in Lamp Tests When Determining the Best Available Lamp for Central Station Use. S. E. Doane. Abstract of paper read before the Northwestern Electrical Assn. Thinks the most important consideration is that the true rated candles be properly determined. In the writer's judgment they are the maximum reached. 2700 w. Elec Wld—June 25, 1898. No. 21110.

Lighting Plant.

A Modern Arc Lighting Plant. Describes an interesting transformation being carried out in Brooklyn, by which a generating station dependent upon boilers and steam engines for motive power is being changed into one directly driven by high tension three-phase current. Ill. 2000 w. Am Elect'n—June, 1898. No. 20762

Lightning.

The Effect of Lightning upon Overhead Power Circuits and the Cheapest Method of Distributing Power. Arthur H. Gibson. Gives statements relating to a power transmission plant installed in South Africa, in a district particularly infested by lightning, giving peculiar behavior of arresters. Advises polyphase machinery, with sunk windings or hole wound, where lightning is troublesome. 1500 w. Elec Rev, Lond—June 3, 1898. No. 20818 A.

Public Lighting.

Public Lighting in Relation to Public Ownership and Operation. Alex. Dow. Abstract of a paper read before the Nat. Elec. Lgt. Assn., at Chicago. Sets forth a proposed policy applicable immediately to public lighting. 4000 w. Elec Wld—June 18, 1898. No. 20853.

Resistances.

Calculation of Electric Resistance Frames. E. Kilburn Scott. Tabulated particulars of iron-wire resistances, with explanatory notes. 1500 w. Prac Eng—May 20, 1898. No. 20572 A.

Signalling.

New System of Electric Signs and Signals. Illustrates and describes a device enabling electric signals to be spelled out on a large frame in lights visible several miles. 1000 w. Sci Am—June 4, 1898. No. 20625.

Small Currents.

Registration of Small Currents Used for Electric Lighting or other purposes. Alfred H. Gibbings. Abstract of a paper read before the Inst. of Elec. Engs., England. Describes a motor which the writer claims will register accurately from $\frac{1}{10}$ ampere to its range limit, dealing with its principle of action and registration, construction and probable cost, tests, &c. Discussion. Ill. 4400 w. Elect'n, Lond—May 20, 1898. No. 20570 A.

Sockets.

Gauges for Incandescent Lamp Sockets. (Kaliberlehren für Glühlampenfüsse.) R. Hundhausen. A discussion of the construction of gauges for the standard lamp socket screw threads recommended by the German Electrotechnical Society. 1800 w. Elektrotech Zeitschr—June 2, 1898. No. 21083 B.

Standard Socket Threads for Edison Lamps. (Normalien für Edison-Gewinde.) R. Hundhausen. A description of the standard screw thread system for incandescent lamp sockets, as recommended by the German Electrotechnical Society. 1800 w. Elektrotech Zeitschr—May 19, 1898. No. 21078 B.

Storage Battery.

A Storage Battery Central Station. F. B. Sage. Illustrated description of the electric light plant of Claremont, N. H., which shows the advantage of storage batteries being applied to small lighting installations. 2000 w. Am Elect'n—June, 1898. No. 20761.

Chicago Edison Company's Storage-Battery Plant. Illustrated description of this latest feature of the central station distribution system of this company. It is the largest battery plant that has ever been installed. 2200 w. W Elect'n—June 4, 1898. No. 20742.

Street Lighting.

The Proper Illumination of City Streets. Henry Hopkins. Considers the requirements for satisfactory street lighting, giving illustrations. 900 w. Elec Eng, N. Y.—June 30, 1898. No. 21221.

Switchboards.

Switchboard Apparatus. J. R. Blaikie. Read at annual meeting of the Municipal Electrical Assn., London. Considers the duties and characteristics of the details, the disposition of the component parts, and shows the necessity of standard work. Also editorial. 8500 w. Elec Rev, Lond—June 10, 1898. No. 20971 A.

220-Volt System.

The 220-Volt and Alternating Current Sys-

tems. George D. Shephardson. A comparison of the two systems, giving the arguments for and against the 220-volt system as advanced by its advocates and opponents. 3800 w. Am Elect'n—June, 1898. No. 20764.

The 220-Volt System of Electric Lighting for Small Municipalities. W. I. Gray. Presents the advantages of this system showing why it has been so well received and describes the construction work. 1600 w. Year Bk of Soc of Eng, Univ of Minn—1898. No. 20664 E.

Wiring Chart.

A Convenient Wiring Chart. R. Laurie Ellis. Illustrates an easy method for performing the calculations graphically, for feeders and service wires. 400 w. Elec Wld—June 25, 1898. No. 21107.

POWER.

Alternating Currents.

Elements of Complex Quantities and Vectors with Reference to Their Use in Alternating-Current Work. Franz J. Dommerque. A study of sine law for electro motive force and current, showing that the E. M. F. changes by sines, while the magnetic flux changes by cosines of the same angle. Ill. 1800 w. Elec Engng—June 1, 1898. No. 20630.

Alternators.

A High or Low Tension Alternator. H. F. M. Dahl. Illustrates and describes the 10 K. W., ten pole, single phase, Slaterry alternator belonging to the electrical engineering department of the University of Minnesota, which was remodeled according to a plan proposed by George D. Shephardson. 1000 w. Year Bk of Soc of Eng, Univ of Minn—1898. No. 20663 E.

Batteries.

Batteries v. Generators. The question of reliance in electricity supply, favoring the storage system. 1500 w. Elec Rev, Lond—June 3, 1898. No. 20817 A.

Central Stations.

The Development of the Central Station. Samuel Insull. A lecture delivered before the School of Electrical Engineering of Purdue University. Part first is largely a review of Mr. Edison's work. 2400 w. Elec Eng, N. Y.—May 26, 1893. Serial. 2 parts. No. 20531 B.

Chart.

Chart. A. B. Herrick. A carefully worked out chart showing the limits within which various systems of transmission can be profitably employed. Elec Eng, N. Y.—June 9, 1898. No. 20753.

Cost.

Analysis of the Cost of the Generation and Distribution of a Unit of Electricity. Calvin W. Rice. Read before the Nat. Elec. Lgt. Assn., at Chicago. A résumé of the most reliable data, showing what has been done and what is being done. Considers the cost of the plant, cost of operation, &c. With discussion. 9500 w. Elec, N. Y.—June 22, 1898. No. 20990.

Distribution.

European Methods of Underground Distribu-

tion. Francis Jehl. Shows that European countries improve their cables, making them self-protective, instead of building expensive conduits, as is customary in England and America. Illustrates and describes methods used. 5000 w. Am Elect'n—June, 1898. No. 20766.

General Distribution from Central Stations by Alternating Currents. Herbert A. Wagner. Paper read before the Nat. Elec. Lgt. Assn., at Chicago. Compares and contrasts the different methods of distribution, reviewing those in general use, and describing the most recent developments, stating the features in which the alternating current has been shown to be superior. Elec Eng, N. Y.—June 16, 1898. No. 20863.

General Distribution from Central Stations by Direct Currents. Louis A. Ferguson. Read before the Nat. Elec. Lgt. Assn. at Chicago. Explains the method of distribution employed in the system of the Chicago Edison Co., considering what method gives the best efficiency, the value of the storage battery, its adaptation to elevator work, and other matters of interest. 7000 w. Elec Eng, N. Y.—June 16, 1898. No. 20865.

Economy Test.

An Economy Test of a Central Station. W. E. Goldsborough. An account of a number of tests made at one of the large electric lighting stations of Baltimore, Md., to determine along what lines, if any, the method of operating the station could be modified to improve its efficiency. Ill. 15000 w. Trans Am Inst of Elec Eng—April, 1898. No. 20991 D.

Electric Driving.

Electrically-Driven Calico Printing and Finishing Machinery. Presents the advantages of electric power in this work and gives illustration of a plant established in one of the largest Lancashire print works, noting some of the difficulties met. 800 w. Engr, Lond—May 27, 1898. No. 20705 A.

Electric Plows.

Electric Motor Plows. (Der Elektrische Motorflug.) Dr. Müllendorf. A very fully illustrated description of the Zimmerman system of electric plows showing a complete installation, and giving detailed tabular statements of costs of maintenance and operation. 5000 w. Elektrotech Zeitschr—June 2, 1898. No. 21082 B.

Elevators.

Electric Elevators, with Special Reference to Their Starting and Stopping. W. C. C. Hawtayne. Read before the British Northern Soc. of Eng. Part first describes the Otis passenger elevator, the precautions taken to secure safety. 2300 w. Elec, Lond—May 20, 1898. Serial. 1st part. No. 20569 A.

Gas Plant.

A Gas Engine Central Station. J. J. Flather. Describes and illustrates an interesting installation at Lafayette, Ind., involving the most modern practice in gas engine construction and operation, and showing the economy obtainable under favorable conditions. 2400 w. Am Elect'n—June, 1898. No. 20760.

Generating Stations.

Single v. Multiple Generating Stations. John

F. C. Snell. Read at meeting of Municipal Electrical Assn., London. The writer favors multiple stations and discusses their advantages. Also editorial. 2800 w. Elec Rev, Lond—June 10, 1898. No. 20972 A.

The Law of Electric Generating Stations. The text of the report agreed upon by the Select Committee of both Houses of Parliament. 2200 w. Elect'n, Lond—June 10, 1898. No. 20977 A.

Generators.

Direct Current Generators in Parallel. Frank W. Springer. Outlines methods of obtaining characteristic curves, and discusses points of importance where generators are paralleled. 3800 w. Year Bk of Soc of Eng, Univ of Minn—1898. No. 20665 E.

Insulation.

Insulation and Conduction. Reginald A. Fessenden. Gives an account of the manner in which a current passes through materials, discussing also the purposes for which insulation is used, and of substances best suited. Discussion and communications. 17000 w. Trans of Am Inst of Elec Eng—March, 1898. No. 20629 D.

Insulation Resistance and Leakage Currents. Alexander Russell. A method of testing the wiring of a building in a two-wire installation and a three-wire installation, and a discussion of the importance of accurate testing. 3000 w. Elect'n, Lond—June 10, 1898. No. 20976 A.

Leakage.

A Discussion of the Conditions of Leakage in Electric Machines. (Ein Beitrag zur Beurtheilung der Streuung Elektrischer Maschinen.) A. Rothert. A mathematical discussion of magnetic leakage in generators and motors. 5000 w. Elektrotech Zeitschr—May 26, 1898. No. 21080 B.

Marine Plant.

Electrical Apparatus on Shipboard. (Ueber Elektrische Schiffseinrichtungen.) A general description of marine electrical apparatus, including engine-room indicators, hoisting machines, steering devices, &c. 4500 w. Elektrotech Zeitschr—May 12, 1898. No. 21077 B.

Electric Power Transmission on Shipboard. F. W. Roller. Shows that auxiliary steam engines have a minimum of good qualities, although superior to hydraulic or pneumatic systems, and claims that an electrically driven installation would overcome most of the difficulties. 1800 w. Am Elect'n—June, 1898. No. 20767.

Motor Design.

The Design of Electric Railway Motors for Rapid Acceleration. Charles A. Carus-Wilson. Read at meeting of Inst. of Elec. Engs., England. A mathematical study. 6200 w. Elec Eng, Lond—May 27, 1898. No. 20702 A.

Niagara.

Developing Power of Lower Niagara. Orrin E. Dunlap. Concerning the development of the rapids of the lower Niagara. Map. 1600 w. W Elect'n—June 18, 1898. No. 20930.

Power Plants.

A Great Power House at Niagara. An illustrated description of the recent developments of

the water power of Niagara Falls. 1700 w. Sci Am—June 18, 1898. No. 20854.

Economical Manner of Working Steam in Electric Power Plants. William S. Aldrich. Considers the increased economies to be obtained in the manner of working steam in the engine cylinders. 2700 w. Am Elect'n—June, 1898. No. 20768.

Electric Station at Amparo, Brazil. (Station d'Electricité du Amparo, Brésil.) Illustrated account of the hydraulic-power electric-lighting station for the city of Amparo, with views of the power plant and diagram of the distribution. 1200 w. Le Génie Civil—May 28, 1898. No. 21007 D.

Electric Power at the Golden Gate Mill, Utah. Describes the installation for operating the largest cyanide mill in the world. Ill. 1400 w. Eng & Min Jour—June 25, 1898. No. 21170.

Power Plant of the Columbia Water Power Company. Describes the installation of this company, which utilizes the water of the Broad River, and includes a development of 3000 h. p. which is to be increased to 10,000 h. p. 1500 w. Elec Wld—June 11, 1898. No. 20748.

Power Plant of the New York and Staten Island Electric Company. Illustrated description of the new station which generates all the electric current used for lighting on the whole island, and most of the electric power used for traction purposes. 2800 w. Elec Wld—June 11, 1898. No. 20747.

Steam-Using Plant. J. A. Jeckell. Read at meeting of Munic. Elec. Assn., London. Discusses various types of engines and their efficiency, and other means of economy and efficiency. Discussion. 5300 w. Elec Eng, Lond—June 10, 1898. No. 20975 A.

The Central Heating, Lighting and Power Plant. L. P. Breckenridge. Describes and illustrates the new plant for the buildings of the Univ. of Illinois. 1200 w. Technograph, No. 12—1897-8. No. 20912 D.

The Missouri-Edison Electric Company of St. Louis and Its Development of the Alternating Current System for Light and Power Distribution. Herbert A. Wagner. An interesting historical account of this company with illustrated detailed description of the three stations. 11000 w. Elec Eng, N. Y.—June 9, 1898. No. 20752.

The Missouri-Edison Plant in St. Louis. George J. Percival. An illustrated description of the general features of the three stations of this company. 2300 w. Elec Wld—June 11, 1898. No. 20750.

The Utilization of the Water Power of the Muotta, near Schwyz. (Die Ausnützung der Wasserkräfte der Muotta oberhalb Schwyz.) A Forti. With views of the weir, and plans of the tunnel and power house, and a topographical map. 1200 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—June 3, 1898. No. 21054 B.

Reconstruction.

The Metamorphosis of an Electric Power Station. Illustrated description of changes made in the Albany street station in Boston. 1000 w. Power—June, 1898. No. 20626.

Transmission.

The Yuba-Marysville Transmission. Illus.

trated detailed description. 8000 w. Jour of Elec—May, 1898. No. 20983.

Uniformity.

On the Necessity of Uniformity in Plant and Apparatus. C. H. Wordingham. Read before the Munic. Elec. Assn., London. On the importance of restriction of the number of types and sizes of the articles produced. Argues that the electrical industry has reached that point in its development that makes this economy desirable. Discussion. 5000 w. Elec Eng, Lond—June 17, 1898. No. 21190 A.

TELEGRAPHY AND TELEPHONY.

Cables.

Submarine Telegraphy. A description of the cable lines of the world. 2300 w. Elec Rev, N. Y.—June 8, 1898. No. 20751.

Vibrating Cable Relay. K. Gulstad. Describes a cable relay for automatic working, or a special arrangement of interest. Ill. 1400 w. Elec Rev, Lond—June 3, 1898. Serial. 1st part. No. 20315 A.

Combined Systems.

Operating Telephone and Electric-lighting Systems in Conjunction. H. P. Clausen. Some valuable suggestions on the construction, operation and management of telephone systems of this character. Ill. 2000 w. W Elect'n—June 4, 1898. No. 20743.

Field Telephones.

The Telephone in War. Arthur R. Pardington. Describes the long distance equipment at Camp Black, and its valuable services. 700 w. Elec Rev, N. Y.—June 15, 1898. No. 20848.

Manufacturing Plants.

Telephone Systems for Large Manufacturing Plant. H. P. Clausen. Illustrated description of a simple manually operated system, wherein all calls are transmitted by the caller. 1800 w. W Elect'n—May 28, 1898. No. 20553.

Semaphore.

Semaphore Telegraph. Reviews the history of this system, now nearly out of use. 1200 w. Engr, Lond—June 3, 1898. No. 20828 A.

Space Telegraphs.

The Mooted Wireless Telegraphs. D. H. Keeley. A discussion of the different systems, and the possibilities. 2000 w. Can Elec News—June, 1898. No. 20869.

MISCELLANY.

Battery.

A Novel Form of Thermo-Electric Battery. C. J. Reed. Describes experiments which give further proof of the high thermo electric power of metals in contact with electrolytes, with explanation of the results. Discussion. Ill. 10500 w. Trans Am Inst of Elec Engs—April, 1898. No. 20992 D.

Cooking.

Electric Cooking Apparatus. (Elektrische Kochapparate.) A description of the Voigt & Häffner apparatus, which, according to tests by Dr. Kittler, showed an efficiency of over 80 per cent. 1500 w. Gesundheits Ingenieur—May 31, 1898. No. 21068 B.

Electric Heating.

See Architecture and Building, Heating.

Geissler Tubes.

A Theory to Explain the Stratification of the Electric Discharge in Geissler Tubes. H. V. Gill. Presents certain ideas regarding the cause of this phenomenon, and describes some experiments made to test the value of these ideas. Ill. 8000 w. Am Jour of Sci—June, 1898. No. 20658 D.

Hertz Waves.

The Hertz Electric Waves, and the Consequent reform in Physics. (Ueber die Hertzischen Elektrischen Schwingungen und die damit Zusammenhängende Reform der Physik.) Dr. Holzmüller. An elementary investigation of the Hertz waves, showing their relation to general physical problems. 5000 w. Zeitschr d Ver Deutscher Ing—June 4, 1898. No. 21047 D.

Induction.

On the Surface Tension of Liquids under the Influence of Electrostatic Induction. Samuel J. Barnett. Gives a brief discussion of previous work in this field, and describes a method of investigation which has proved more satisfactory than those hitherto employed—the method of ripples in its latest form. 7800 w. Phys Rev—May-June, 1898. No. 20898 D.

Insulation.

Testing the Insulation of Conductors of Street Railways. (Isolations Prüfung von Zeitungen Elektrischen Strassenbahnen.) M. Stobrawa. The perfection of the insulation is tested by the relative brightness of two series of incandescent lamps connected between the collecting bar and the earth circuit. 1200 w. Elektrotech Zeitschr—May 12, 1898. No. 21074 B.

The Effects of Temperature on Insulation Materials. William Esty. Describes tests, apparatus, and methods used in the electrical laboratory of the Univ. of Illinois, to determine the behavior of insulating materials under different physical conditions. 4100 w. Technograph, No. 12—1897,-8. No. 20909 D.

Lightning.

Lightning and Lightning Arresters. H. E. Raymond. Gives the results of several years' observations and experiments in the line of protection against damage from atmospheric disturbances. 3800 w. Elec Wld—June 11, 1898. Serial. 1st part. No. 20749.

Magnetic Balance.

Ewing's Magnetic Balance for Workshop Use. (Ewing's Magnetische Wage für den Gebrauch in der Werkstätte.) The methods of calibrating and applying the balance in practical work is discussed. 2000 w. Elektrotech Zeitschr—May 26, 1898. No. 21081 B.

Magnetism.

Effects of Prolonged Heating on the Magnetic Properties of Iron. S. R. Roget. Read before the Royal Society. Reports results of experiments carried out in the laboratory of Cambridge University, investigating an extended range of temperature. 1300 w. Elect'n, Lond—June 3, 1898. No. 20842 A.

Experiments with Koepsel's Apparatus for the Determination of the Magnetic Properties of Iron. (Untersuchungen über den Koepsel'schen Apparat zur Bestimmung der Magnetischen Eigenschaften des Eisens.) Dr. E. Orlich. An account of elaborate investigations made at the Reichsanstalt. The apparatus is a sort of reversal of the d'Arsonval galvanometer. 3000 w. Elektrotech Zeitschr—May 12, 1898. No. 21-076 B.

The Reliability of Magnetic Tests Made with a d'Arsonval Ballistic Galvanometer. Samuel Sheldon and Townsend Cocks. Investigations which lead to the conclusion that the results are to be relied upon when the galvanometer is properly manipulated. 1000 w. Elec Wld—June 18, 1898. No. 20852.

Oscillations.

An Experimental Determination of the Period of Electrical Oscillations. Arthur Gordon Webster. Researches concerning the experimental verification of the formula giving the period of the oscillations of an alternating current arising when a charged condenser is discharged through a circuit containing self-induction. Ill. 5000 w. Phys Rev—May-June, 1898. No. 20900 D.

Radiography.

A Simple Explanation of Some Celestial Phenomena by the Cathode Rays. (Explication Simple de Plusieurs Phénomènes Célestes par les Rayons Cathodiques.) A communication to the French Academy from M. H. Deslandres, suggesting an explanation for some of the phenomena of the solar corona during a total eclipse. 1800 w. Comptes Rendus—May 9, 1898. No. 21026 D.

Cathode Rays in an Oscillating Electric Field. Discusses the theory most in favor in England, giving investigations of J. J. Thomson, Jau-man, and others, especially explaining the investigations of Prof. Ebert, of Kiel. 2800 w. Elec Rev, Lond—June 3, 1898. No. 20816 A.

On the Fall of Potential at the Surface of a Metal When Exposed to the Discharging Action of the X-Rays. C. D. Childs. An account of experiments made, giving results. 1800 w. Phys Rev—May-June, 1898. No. 20399 D.

Recent Improvements in X-Ray Tubes. H. Lyman Sayen. Discusses "radiant matter" and its properties and briefly describes a tube

designed by the writer. 2000 w. Jour Fr Inst—June, 1898. No. 20670 D.

Some New Studies in Kathode and Röntgen Radiations. Alan A. Campbell Swinton. Abstract of discourse delivered at the Royal Inst. Reviews the methods of producing kathode discharges, the theories more generally accepted, late work and results. Ill. 3800 w. Nature—May 26, 1898. No. 20700 A.

The X-Rays and Their Safe Application. J. Mount Bleyer. Read before the Medico-Legal Soc, New York. Notes on precautions necessary in X ray examinations, and method of treatment when from unforeseen causes an injury has been inflicted. 2000 w. Elec, N. Y.—June 15, 1898. No. 20861.

Rheostat.

The Ferrand Automatic Rheostat. (Rhéostat Automatique, Système J. Ferrand.) The Ferrand rheostat is arranged with discs of carbon of which the resistance is automatically varied by change of pressure. 1200 w. L'Electricien—May 28, 1898. No. 21090 B.

Smelting.

See Mining and Metallurgy, Miscellany.

Switchboards.

Switchboard Reconstruction. Albert B. Her-rick. A review of the modern methods adopted in switchboard construction. Ill. 2500 w. Am Elect'n—June, 1898. No. 20765.

Transformers.

Current Transformers. Charles T. Child. Part first shows the necessity of transforming one kind of current into another, and reviews the methods which have been employed, as an introduction to a description of a reversible transformer. 2700 w. Elec Eng, N. Y.—May 26, 1898. Serial. 2 parts. No. 20530 B.

Transformer Economy. Winder Elwell Golds-borough. Abstract of paper read before the Nat. Elec. Lgt. Assn., at Chicago. Discusses the results of a test at Purdue laboratories of a number of transformers of recent design, giving also much information about transformers. 4200 w. Elec Wld—June 25, 1898. No. 21108.

Transformer Regulation. A. R. Everest. Discusses methods of determining the regulation of a transformer. 1800 w. Elec Wld—June 4, 1898. No. 20600.

MARINE ENGINEERING.

High Speed.

A Vessel for High Speed. H. C. Vogt. An investigation of how to obtain high speed on the seas, based on a study of marine animals and their rapidity in swimming. Ill. 2300 w. Steamship—June, 1898. No. 20735 A.

Launch Engines.

The Design and Construction of Small Steam-Launch Engines. Part first considers the requirements of launch machinery, the present tendency in engine design, &c. 1800 w. Mech Wld—May 27, 1898. Serial. 1st part. No. 20699 A.

Marine Engines.

On Taking Charge of a Marine Engine. A.

B. Wilhitts. Presents the leading points to be looked after in taking charge of marine machinery, aiming to aid engineers suddenly called upon. 4500 w. Engr, N. Y.—June 15, 1898. No. 20871.

Marine Plant.

See Electrical Engineering, Power.

Oil Fuel.

Oil Fuel Experiments on Hydraulic Life Boat "Queen." John Platt. A general description of the boat and the results of a series of experiments made burning both coal and oil in a Thornycroft boiler. Ill. 2300 w. Jour of Am Soc of Naval Engs—May, 1898. No. 20680 H.

Repairs.

Marine Engine Repairs. J. Kyles. Read at meeting of the Inst. of Engs and Shipbuilders of Hong Kong. Notes on a few of the most important engine repairs. 5000 w. Steamship—June, 1898. No. 20736 A.

Resistance.

The Determination of the Resistance of Vessels by Experiments with Models. (Die Bestimmung des Schiffswiderstandes auf Grund der Versuche mit Modellen.) A paper by Herr Schromm, discussing the influence exerted by the shape and dimensions of the tank or channel upon the resistance to motion. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—June 10, 1898. No. 21056 B.

Shafts.

The Breaking of Propeller Shafts. (La Rupture des Arbres de Couche.) A discussion of the accidents at sea by reason of shaft breakages, with reference to a large number of recent instances; suggesting methods of repair at sea. 1800 w. La Revue Technique—May 25, 1898. No. 21018 D.

Ship.

The Four-Masted Ship "Kenilworth." Illustrated description of a fine American iron ship. 1200 w. Am Shipbuilder—June 23, 1898. No. 21152.

Steamship.

Details of Largest Wooden Steamship in Commission in the World. Illustrated description of the steamship "Thomas Cranage," a cargo vessel on the Great Lakes. 1500 w. Marine Engng—June, 1898. No. 20716 C.

The Latest North German Lloyd Passenger Steamer. Description of the "Kaiser Fried-

rich," which has recently made its maiden trip from Bremen to New York. 1000 w. Eng News—June 23, 1898. No. 21119.

U. S. Steamer "Fulton"—Her Design, Construction and Capacity. Charles H. Haswell. An account of the first sea steamer constructed by the U. S. navy. 1000 w. Jour Am Soc of Naval Engs—May, 1898. No. 20684 H.

Twin Screws.

Experiments on the Effect of Direction of Turning in Twin Screws. R. E. Froude. Gives results of model experiments in the comparative efficiency of the two directions of turning. Discussion follows. 2400 w. Jour Am Soc of Naval Engs—May, 1898. No. 20686 H.

Yachts.

American Steam Yachts. Irving Cox. Introductory remarks comparing English and American yachts, with illustrations and brief descriptions of representative craft. 3300 w. Jour of Am Soc of Naval Engs—May, 1898. No. 20681 H.

The High-Speed Steam Yacht as a Factor in Torpedo Boat Design. W. P. Stephens. The first article deals principally with the historical development of the high speed steam yacht, with an account of the successive products of leading builders on both sides of the Atlantic. 4000 w. Engineering Magazine—July, 1898. No. 21-238 B.

Yukon Steamers.

Novel Type of Towing Steamers and Barges for Service on the Yukon. Illustrates and describes the eight new boats for the Yukon. They will operate in two fleets, each consisting of one tug, two freight barges, and one passenger barge. 1800 w. Marine Engng—June, 1898. No. 20718 C.

MECHANICAL ENGINEERING.**BOILERS, FURNACES AND FIRING.****Boiler Ordinance.**

The New Law in Saxony for Multitubular Boilers. (Le Nouveau Règlement Saxon pour les Chaudières Multitubulaires.) Ch. Bellens. An examination of the recent Saxon regulations, with especial reference to water-tube boilers, giving a sketch of a boiler conforming fully with the official requirements. 1500 w. La Revue Technique—May 10, 1898. No. 21015 D.

Boiler Plant.

The Boiler Plant of Arbuckle Brothers' Sugar Refinery, Brooklyn, N. Y. Illustrated description of plant, noteworthy for the numerous devices for the saving of space, labor and fuel. 900 w. Eng News—June 2, 1898. No. 20614.

Boiler Test.

Tests of a Horizontal Return Tubular Boiler with Two Kinds of High Grade Bituminous Coal. H. Barrus. Describes tests, giving results. 700 w. Eng Rec—June 4, 1898. No. 20651.

Test of an Experimental Boiler. Reports the results of a test made upon curved water legs. Ill. 1700 w. Locomotive—May, 1898. No. 21149.

Corrosion.

The Corrosion of Iron. S. W. Parr and A. E. Paul. Results of a series of experiments conducted for the purpose of determining the conditions favoring the corrosion of iron—or to reproduce as nearly as possible the conditions existing inside of steam boilers. 600 w. Technograph, No. 12—1897-8. No. 20914 D.

Calorimeters.

Steam Calorimeters: Construction, Value and Use to the Engineer. A. H. Eldredge. Presents two of the principal forms of calorimeters for determining the quality of steam, with the methods of using and their importance in boiler trials. Ill. 1500 w. Prac Eng—June 3, 1898. No. 20741 A.

The Determination of Water in Steam. (Die Mengenbestimmung des Wassergehaltes im Kesseldampf.) Ernst Brückner. A very full examination of the various methods of testing moisture in steam, with illustrations of calorimeters, methods of attachment, &c. 12000 w. Zeitschr d Ver Deutscher Ing—May 28, June 4, 11, 1898. Three articles, No. 21039 each D.

Draft.

Mechanical Draft for Steam Boilers. W. B.

Snow. Presents the economical advantages of mechanical draft, showing it is capable of reducing losses, decreasing the first cost of a steam generating plant, and reducing the fuel expense. 4000 w. *Sib Jour of Engng*—June, 1898. No. 20675 C.

The Advantages of Mechanical Draft. Walter B. Snow. Presents the general economic advantages, and those relating to the convenience and operation, showing the saving by considering a typical plant. Ill. 3000 w. *Am Elect'n*—June, 1898. No. 20763.

Economisers.

A Discussion of Economiser Feed Water Heaters. (Note sur les Economisers-Réchauffers d'Eau.) A general examination of the performance of economisers, showing the extent to which economy may be expected, and indicating the most effective arrangement. 6000 w. 1 plate. *La Revue Technique*—May 25, June 10, 1898. Two articles. No. 21017 each D.

Explosion.

The Fatal Boiler Explosion at Bury. Gives the investigations by the Board of Trade into the causes and circumstances. The tramways company are severely blamed. Also editorial. 3000 w. *Prac Eng*—June 17, 1898. No. 21200 A.

Fuel Test.

The Examination of Combustible Minerals by X Rays. (Examen d'un Combustible Minéral au Moyen des Rayons de Röntgen.) A note by M. Couriol, showing that combustible materials are transparent, and non-combustible, opaque to X rays, and that the purity of a fuel can be determined instantly in this manner. 800 w. *Compte Rendus*—May 31, 1898. No. 21032 D.

Oil Filter.

An Oil Filter for Boiler Feed Water at Peoria, Ill. Dabney H. Maury, Jr. Read before the Buffalo convention of the American Water-Works Assn. An account of the various experiments tried and the final success, with statement of conditions under which the filters and boilers were operated. Ill. 2800 w. *Eng News*—June 23, 1898. No. 21117.

Repairs.

See Shop and Foundry.

Riveted Seams.

Defects in Riveted Seams of Boilers. (Etude sur les Avaries de Certaines Chaudières dans la Région des Rivures Circulaires.) Ch. Frémont. A discussion of the causes of cracks along longitudinal riveted seams, with photographic illustrations. 1500 w. *Bulletin de la Société d'Encour*—May, 1898. No. 21035 G.

Stoker.

Proctor's Mechanical Stoker. Illustrated description of a design the chief feature of which is a ram, or impeller, for the fuel, which is worked with a horizontal reciprocating motion by means of cams and levers. 1800 w. *Engng*—June 20, 1898. No. 20955 A.

Vertical Boiler.

A Vertical Steam Boiler of Novel Design.

Illustrated description of an internally fired vertical tubular boiler designed by Dean and Main. 600 w. *Eng News*—June 23, 1868. No. 21118.

Water-Heater.

Notes on a Water-Heater at Cadzow Colliery. William S. Thomson. Read before the Mining Inst. of Scotland. Illustrated description with advantages gained. 900 w. *Col Guard*—June 17, 1898. No. 21178 A.

Water-Tube.

A New Water-Tube Boiler. Illustrates and describes what is known as the "Johnston" water-tube boiler, manufactured by the Brownell Co., of Dayton, Ohio. 1000 w. *Eng News*—June 2, 1898. No. 20613.

Novel Arrangement of Feed-Water Heater in Water-Tube Boilers. A. F. Yarrow. Describes experiments made which prove the advantage of the new feed system. Discussion. 4300 w. *Jour Am Soc of Naval Engns*—May, 1898. No. 20683 H.

COMPRESSED AIR.

Compressors.

Air Compressors at High Altitudes. F. A. Halsey. Shows that the air produced is not proportional to the barometric pressure, and the value of compound compressors in such locations. 1300 w. *Am Mach*—June 2, 1898. No. 20632.

Diagrams.

Diagrams for Compressed Air.—Horse-Power and Temperature. J. E. Johnson, Jr. Diagrams platted to supply a quick and convenient means of obtaining fairly accurate solutions of these two questions in connection with compressed air. 2000 w. *Am Mach*—June 23, 1898. No. 21112.

Motors.

Compressed Air Motors. Describes in detail the distinctive features of the Hoadley-Knight system of street-railway operation. Ill. 2800 w. *Compressed Air*—May-June, 1898. No. 20564. See also *Municipal Engineering, Water Supply*.

ENGINES AND MOTORS.

Compound Engines.

Engines of the Ferry Steamer Chebucto. Illustrated description of the driving-engines and other machinery. 700 w. *Engr, Lond*—May 20, 1898. No. 20577 A.

Non-Condensing Compound Engines for Office Buildings. Editorial discussion of their value compared with simple engines. 1600 w. *Eng Rec*—June 18, 1898. No. 20933.

The Effect of Size upon the Economy of Compound Engines. An analysis of comparable tests showing large cylinders to give from 2 to 5% better results. 500 w. *Eng Rec*—June 4, 1898. No. 20642.

Diesel Motor.

The Merits of the Diesel Motor. From the paper of Aimé Witz to the Academy of Science. Notes that the absolute efficiency remains the same whatever the work may be, and the value of this property. 700 w. *Automotor Jour*—June 15, 1898. No. 21204 A.

Entropy.

Entropy and Temperature-Entropy Diagrams. W. F. Durand. Showing that entropy should be considered as a relation rather than a property, and explaining very fully the method of constructing and using the temperature-entropy diagram for any given case. 12800 w. Jour Am Soc of Naval Engs—May, 1898. No. 20-678 H.

Gas Engines.

Marine Gasoline and Gas Engines as Used in Modern Motor Boats. Cecil H. Peabody. A statement of the principle of these engines and the difficulties in their design and construction. 2600 w. Marine Engng—June, 1898. Serial. 1st part. No. 20717 C.

See Municipal Engineering, Water Supply.

Gas Power.

Gas Power and Electricity. (Gaskraft und Elektrizität.) A discussion of the relative merits of gas and electric motors; also of the economy of gas engines for the driving of electric generators. 4000 w. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21043 D.

Gas Power. J. E. Dowson. Read at meeting of the Fed. Inst. of Min. Engs., London. Gives a historical sketch of gas engines, the alterations and improvements, the trials and cost of maintenance. 2300 w. Ir & Coal Trds Rev—May 20, 1898. No. 20566 A.

Governors.

Steam Engines with Shaft Governors. (Dampfmaschinen mit Flachreglern.) Hugo Seidler. An illustrated discussion showing forms of shaft governor used in Germany, with diagrams showing the closeness of regulation. 4000 w. Zeitschr d Ver Deutscher Ing—May 14, 1898. No. 21036 D.

The Shaft Governor. Henry E. Longwell. A discussion of Prof. Carpenter's article with notes from the writer's experience. 2200 w. Power—June, 1898. No. 20627.

The Shaft Governor. Thomas Hall. Considers some of the problems presenting themselves in the endeavor to secure good regulation. Ill. 3500 w. Elec Wld—June 4, 1898. No. 20601.

Link Motion.

The Distribution of Work in Compound Engines by the Link Motion. (Die Arbeitsverteilung bei Verbundmaschinen mit Kulissensteuerung.) W. Schwarz. Giving a graphical method for determining the work performed at various points of cut-off. 1000 w. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21042 D.

Pistons.

Packing Piston Rods. W. H. Wakeman. Gives points on the packing and oiling of piston rods. 800 w. Am Mach—June 23, 1898. No. 21113.

Pumping Engine.

The Holst Pumping Engine. Illustrates and describes a new system of pumping engine designed by C. P. Holst, of Amsterdam, Holland. The water flows in a constant stream. 1000 w. Am Mach—June 9 1898. No. 20757.

Steam Economy.

The Economical Use of Steam in Non-Condensing Engines. James B. Stanwood. A discussion of the economy which may be obtained by the throttling compound non-condensing engines as compared with the automatic cut-off type. 3000 w. Engineering Magazine—July, 1898. No. 21236 B.

Steam Turbine.

Parson's Patent. Report of the proceedings of the Judicial Committee of the Privy Council in regard to the extension of the patent of Charles Algernon Parsons for steam turbines, with editorial. 3300 w. Engr, Lond—May 20, 1898. No. 20579 A.

Stopping Device.

An Automatic Device for Stopping Engines. Illustrates an apparatus, worked by electricity from any part of a shop. 1200 w. Eng Rec—June 18, 1898. No. 20938.

Traction Engines.

Latest Types of American Traction Engines. William Fletcher. A brief comparison of some of the best American traction engines with the road engines manufactured in England, with description of American types. Ill. 2500 w. Engr, Lond—June 10, 1898. Serial. 1st part. No. 20965 A.

Valve Diagram.

The Application of the Double Valve Diagram. (Ein Beitrag zur Beurtheilung der Zweischiebersteuerung.) K. Gelinek. A discussion of the application of the Müller valve diagram to slide valve gears with cut-off valve operated by a separate eccentric. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—May 27, 1898. No. 21053 B.

Valve Diagrams for Corliss Valve Gear. (Schieberdiagramme für Corlisssteuerungen.) A Seemann. Showing how the Müller valve-diagram may be applied to the Corliss engine, giving accurate results with little labor. 2500 w. Zeitschr d Ver Deutscher Ing—June 11, 1898. No. 21044 D.

Valves.

Piston Valves. W. Reviews the experience gained in developing the piston valve as used in locomotive engineering, showing that it may or may not be as well balanced as a slide valve, 1100 w. R R Gaz—June 10, 1898. No. 20793.

Vertical Engines.

Vertical and Horizontal Engines for Stationary Plants. (Stehende und Liegende Dampfmaschinen für Stationäre Anlagen.) R. A. Zeise. Showing the constructive and operative advantages of vertical engines. 2500 w. I plate. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21040 D.

POWER AND TRANSMISSION.**Gas Plant.**

See Electrical Engineering, Power.

Power Plants.

See Electrical Engineering, Power.

Power Gas.

The Application of Furnace Gases for the Direct Generation of Power. (Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung.) F. Lürmann. A general review of the results obtained at Seraing and Wishaw and of the discussion at the meeting of the Iron and Steel Institute. 7500 w. Stahl und Eisen—June 1, 1898. No. 21073 D.

The Utilization of Blast Furnace Gas. (De l'Emploi des Gaz de Hauts Fourneaux.) A discussion of the results obtained with blast furnace gases in gas engines at Seraing, Belgium, and Wishaw, Scotland. 3000 w. Le Génie Civil—May 21, 1898. No. 21002 D.

The Utilization of Blast Furnace Gases. (De l'Utilisation des Gaz des Hauts Fourneaux.) H. Hubert. A discussion of the chemical and thermal features of the problem in the light of the experience at Seraing. 2500 w. Revue Universelle des Mines—May, 1898. No. 21095 H.

The Utilization of Blast Furnace Gases. (De l'Emploi des Gaz de Hauts-Fourneaux.) A. Greiner. A detailed report of the results of the use of blast furnace gases in gas engines, at the Cockerill Works at Seraing, Belgium, by the General Manager of the company. 3000 w. Revue Universelle des Mines—May, 1898. No. 21096 H.

Water Power.

Water Power Plant at the "Soo." Gives general description of the construction of a plant at Sault Ste. Marie, Mich., for which tenders are invited. 1200 w. Ry & Engng Rev—May 28, 1898. No. 20562.

SHOP AND FOUNDRY.**Automatic Valve.**

An Automatic Stop Valve. (Sur une Valve-Clapet Automatique d'Arret.) The Groignard valve can be opened by hand, and will remain open until closed, unless the pipe should burst in which case it closes automatically by the action of the escaping steam. 1200 w. Bulletin de la Société d'Encour—May, 1898. No. 21034 G.

Self-Acting Stop and Regulating Valves. (Selbstthätiges Absperr- und Regel-Ventil.) Describing and illustrating several forms of the Koch automatic stop valve, which closes of itself if a burst pipe permits an escape of steam. 2000 w. Zeitschr d Ver Deutscher Ing—June 4, 1898. No. 21048 D.

Bearings.

Roller Bearings. W. B. Marshall. Read at meeting of the Fed. Inst. of Min. Engs., London. Shows the difference between rolling and sliding motion, states the requirements of a satisfactory roller bearing, giving some results obtained from their application. 3000 w. Ir & Coal Trds Rev—May 20, 1898. No. 20565 A.

Brass.

A Talk on Brass Founding. Charles Vickers. Read at Cincinnati meeting of Am. Foundrymen's Assn. Considers methods used in various classes of work to secure the best results. 1600 w. Ir Age—June 16, 1898. No. 20858.

Brass Foundry Practice. K. K. Gives illustrated description of methods used and found capable of producing good results. 1300 w. Foundry—June, 1898. No. 20674.

Buildings.

Incombustible Foundry Buildings. O. Benson. Read at Cincinnati meeting of the Am. Foundrymen's Assn. Presents the advantages of steel construction and compares the cost with the wooden structure. Ill. 1600 w. Ir Trd Rev—June 23, 1898. No. 21154.

Castings.

Inspection of Castings. E. H. Putnam. Read at the Cincinnati meeting of the Am. Foundrymen's Assn. Emphasizes the importance of thorough inspection, as early as possible after the casting is made. 1200 w. Ir Trd Rev—June 23, 1898. No. 21153.

Necessity of Well Mixed Furnace Casts and Correct Pig Iron Analyses. Thomas D. West. Read at Cincinnati meeting of Am. Foundrymen's Assn. Advises the use of chemical analysis, and discusses the need of uniform casts of pig iron, and how to obtain them. 1600 w. Ir Age—June 16, 1898. No. 30859.

Straightening Crooked Castings. R. H. Palmer. Discusses some of the causes of crooked castings and means of straightening them. 1600 w. Foundry—June, 1898. No. 20673.

The Manufacture of Steel Castings. Stewart Johnston. Read at Cincinnati meeting of the Am. Foundrymen's Assn. A brief review of the methods employed, with some of the uses. 3000 w. Am Mfr & Ir Wld—June 10, 1898. No. 20798.

Curved Surfaces.

The Fitting of Curved Surfaces. Some suggestions for this work showing the principles involved. 1000 w. Prac Eng—June 3, 1898. No. 20740 A.

Dividing Wheel.

The R. Hoe & Co.'s Dividing Wheel. John Randol. Illustrates and describes the construction and manner of use of a dividing wheel believed to be absolutely true, in a machine shop sense, and to have no measurable variations in its spacing. 1800 w. Am Mach—June 2, 1898. No. 20633.

The Thorne Mechanically Originated Dividing Wheel. John Randol. Illustrated description of a dividing wheel of cheap construction that produces excellent work. 1000 w. Am Mach—June 9, 1898. No. 20756.

Gears.

Cutting Bevel Gears. J. M. Lynch. What a workman should know in order to cut bevel gears with a rotary cutter. Ill. 2800 w. Mach, N. Y.—June, 1898. No. 20617.

Cutting Bevel Gears with Correct Teeth. Gives illustrations with brief descriptions of the most prominent machines used in accurate bevel gear cutting. 1500 w. Mach, N. Y.—June, 1898. No. 20615.

Spiral Gearing. W. H. Van Dervoort. How to design and cut spiral gears. Ill. 3500 w. Mach, N. Y.—June, 1898. No. 20618.

The Mechanism of Gear-Cutting Machines. L. D. Burlingame. Part first deals with indexing for gear-cutting, and considers the styles of indexing mechanism most commonly in use, and the methods to insure accuracy. 2800 w. Mach, N. Y.—June, 1898. No. 20616.

Hardness.

A Test for Hardness of Cast Iron. Charles A. Bauer. Read at the Cincinnati meeting of the Am. Foundrymen's Assn. Describes a test by the use of a drill press, which is believed to be reliable and of practical value. 800 w. Ir Trd Rev—June 9, 1898. No. 20758.

Indicator.

A New Inertia Indicator. Wilfred Lewis. Read before the Engs.' Club of Phila. Describes a convenient device for measuring inertia effects, stating how it came in use and some of its useful applications. Ill. 1600 w. Am Mach—June 23, 1898. No. 21111.

Lathe Dogs.

Automatic Equalizing Lathe Dogs. (Ueber Selbstthätig-Ausgleichende Mitnehmer.) Herman Fischer. Illustrating various methods of driving work by which the turning pressure may be equalized. 2000 w. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21041 D.

Milling Machine.

Vertical Milling Machine for Locomotive Cylinders. (Wagerechte Fräsmaschine für Lokomotivcylinder.) M. Fröhlich. Illustrated description of a powerful new milling machine built by the Alsace Machine Works for the Berlin Machine Tool Co. It is driven by a $5\frac{1}{2}$ h. p. electric motor. 1000 w. Zeitschr d Ver Deutscher Ing—June 11, 1898. No. 21045 D.

Molders.

The Molder of the Future and the Need of an Adequate Apprenticeship System. P. W. Gates. Read at the Cincinnati meeting of Am. Foundrymen's Assn. Discussing means of securing desirable apprentices. 2300 w. Ir Age—June 16, 1898. No. 20857.

Pipe.

Specifications for Cast-Iron Pipe. P. D. Wanner. Abstract of paper read before the Am. Water-Works Assn. Recommendations of an experienced foundryman as to the best methods of making cast-iron pipe and the specifications for the material. 1200 w. Eng Rec—June 25, 1898. No. 21164.

Repairs.

How to Put on a New Boiler, Fit Up Spring Hangers, Driving Saddles, etc. Ira A. Moore. Considers the subjects mentioned, giving illustrations. 1100 w. Loc Engng—June, 1898. No. 20693 C.

Rivet Steel.

The Shearing Strength of Rivet Steel. Arthur N. Talbot. Presents the results of a series of tests made in the Laboratory of Applied Mechanics of the Univ. of Illinois. Ill. 1800 w. Technograph, No. 12—1897-8. No. 20916 D.

Shop Costs.

Effective Systems of Finding and Keeping

Shop Costs. Henry Roland. Describing the method used at the Newton Machine Tool Works, Philadelphia, with accounts of the time keeping system, book forms, tickets, etc. 3500 w. Engineering Magazine—July, 1898. No. 21237 B.

Steel Works.

The Works of the Schoen Pressed Steel Company. Account of these works with illustrations of shops and products. 1600 w. R R Gaz—June 10, 1898. No. 20795.

Tempering.

Tempering by Color. B. F. Spalding. Considers ornamental bluing, methods of heating, tempering sewing machine needles, knife section coloring, gas fuel furnaces, regulation of heat, etc. 2400 w. Am Mach—June 2, 1898. No. 20631.

Test Bars.

The Adoption of a Standard System of Test Bars for Cast Iron. Richard Moldenke. Read before the Am. Foundrymen's Assn., at Cincinnati. Describes the practice of testing in Germany, and discusses the subject in general, urging practical action by the association. 4300 w. Ir Trd Rev—June 9, 1898. No. 20759.

Trolley System.

Trolley Systems—Their Value in Foundry Work. Herbert M. Ramp. Presented at the Cincinnati meeting of the Am. Foundrymen's Assn. Calling attention to some of the good points and advantages of this system. 1900 w. Am Mfr & Ir Wld—June 24, 1898. No. 21219.

Welding.

Welding of Metals. F. V. M'Mullin. States the requirements for a good weld, the methods of welding, etc., and explains why most metals are unweldable. 1600 w. Sib Jour of Engng—June, 1898. No. 20677 C.

MISCELLANY.

Aeronautics.

The Practicability of Long Aerial Voyages. (De la Possibilité des Voyages Aériens au Long Cours.) A discussion of the possibility of investigating the interior of the Sahara and the Soudan by means of a balloon, with the mechanical features of the apparatus. A detailed examination of the problem is given. 6000 w. La Revue Technique—May 10, 1898. No. 21012 D.

Animal Mechanics.

Chronophotography Applied to the Study of Muscular Action in Locomotion. (La Chronophotographie Appliquée à l'Etude des Actes Musculaires dans la locomotion.) An important communication by M. Marey, analyzing the mechanical motions of the horse by continuous photography. 3500 w. Comptes Rendus—May 23, 1898. No. 21030 D.

Automobiles.

Gearing for Automotors. Rhys Jenkins. Some of the most interesting schemes for transmitting the motion of the motor to the driving wheels are briefly noticed. 900 w. Automotor Jour—June, 1898. No. 21203 A.

Light Oil Motors. John Henry Knight.

Presents the advantages and disadvantages of petroleum spirit in motor-cars, with brief discussion of electrical firing. 1500 w. *Automotor Jour*—June 15, 1898. No. 21206 A.

Motor-Vehicle Trials at Birmingham. Illustrated account of the second of the annual trials of the heavy automotors. 1400 w. *Automotor Jour*—June 15, 1898. No. 21205 A.

Motor Wagons. Illustrated description of two vehicles that have been entered for the competition at Liverpool, under the auspices of the Self-Propelled Traffic Assn. 1100 w. *Engng*—May 20, 1898. No. 20581 A.

Motor Wagon Trials at Liverpool. Illustrated description of the four vehicles which competed. 2000 w. *Engr, Lond*—May 27, 1898. No. 20706 A.

Motor Wagon Trials at Liverpool. Profile and maps of the routes traversed, with additional information of results. 700 w. *Engr, Lond*—June 3, 1898. No. 20826 A.

Steam Vehicles for Heavy Traffic. Editorial discussion of the recent competition at Liverpool. Thinks the experiments so far are encouraging for goods traffic by motor wagons. 2200 w. *Engng*—May 27, 1898. No. 20712 A.

Steam Vehicles for Heavy Traffic. Further account of the trials at Liverpool giving the results obtained in the last three days. 2300 w. *Engng*—June 3, 1898. No. 20830 A.

The Automobile Vehicles of the Northern Railway of France. (*Les Voitures Automobiles du Chemin-de-Fer du Nord*.) An account of the steam and electric cabs operated in connection with the Paris terminal of the Northern Railway of France. 2500 w. *Moniteur Industriel*—May 28, 1898. No. 21061 G.

The Liverpool Trials of Heavy Motor Vehicles. A statement of the conditions, and full account of the trials, the routes traveled, the vehicles, &c. Ill. 15000 w. *Automotor Jour*—June 15, 1898. No. 21202 A.

The Scotte System of Automobile Vehicles. (*Les Voitures Automobiles, Système J. Scotte*.) An illustrated description of the Scotte steam omnibus, now successfully used for regular suburban road service in France. 2000 w. 1 plate. *La Revue Technique*—May 10, 1898. No. 21013 D.

Bicycle Motor.

Bicycle with Rotary Petroleum Motor. (*Bicyclette à Pétrole à Moteur Rotatif*.) Illustrating and describing an improved form of petroleum motor bicycle, which has given good results in practice. 1500 w. *La Revue Technique*—June 10, 1898. No. 21022 D.

Bicycles.

The Evolution of the Cycle. W. K. Starley. Introductory remarks upon locomotion generally, followed by a review of the types of cycles, describing the principles and parts of the machine which are still in use to-day. Discussion. 12000 w. *Jour Soc of Arts*—May 20, 1898. No. 20568 A.

The Form and Construction of Bicycles. (*La Bicyclette. Historique,—Forme—Construction*.) A general account of the development of the bicycle from the early hobby-horse to the modern

machine, with many illustrations. 700 w. *Le Génie Civil*—May 28, June 4, 11, 1898. Three articles. No. 21005 each D.

Cable Testing.

Tension Test of a Wire Cable of 90 mm Diameter. (*Prüfung eines Drahtseiles von 90 mm. Durchmesser auf Zugfestigkeit*.) Prof. A. Martens. An interesting account of the test of this heavy cable, with photographic views of the machine and arrangements. 1800 w. *Mitt aus d Kgl Tech Versuchsanstalt*—Part 2, 1898. No. 21070 G.

Chimney.

The Destruction of a Tall Chimney. (*Die Niederlegung eines Stohen Schornsteins*.) Description of the removal of a chimney of 20 feet base diameter, and 260 feet high, by the explosion of charges of roburite in holes drilled in one side at the base. Instantaneous photographs are given of successive stages of the fall. 1000 w. *Zeitschr d Ver Deutschr Ing*—June 11, 1898. No. 21046 D.

Conveying Machinery.

The Design of Elevating and Conveying Machinery. J. V. E. Schaefer. Illustrated description of machinery for the handling of material by means of elevators and conveyors, as shown in the designs used by the Link Belt Machinery Co., of Chicago. 4500 w. *Technograph*, No. 12—1897-8. No. 20910 D.

Coupling.

Pipe Coupling. Describes a coupling brought out by Andrew J. Avery, of Dunkirk, N. Y., which is both gas and water tight under all pressures. 600 w. *Bos Jour of Com*—June 4, 1898. No. 20639.

Drawing.

Drawing and Drawing Instruction. (*Das Zeichnen und der Zeichnenunterricht*.) A paper by H. Pickersgill on the methods of teaching drawing in connection with engineering instruction. 5000 w. *Zeitschr d Ver Deutschr Ing*—June 4, 1898. No. 21049 D.

Hydraulics.

The Flow of Water in a Six-Foot Conduit. An analysis of recent experiments showing possible defects in Kutter formula when used for large steel and wood pipes. 1100 w. *Elec Rec*—June 4, 1898. No. 20643.

Kites.

Kites: Their Theory and Practice. B. F. S. Baden-Powell. The personal experiences of the writer who has given much time to researches in this line, giving a summary of results of experiments. Ill. 3500 w. *Sci Am Sup*—June 4, 1898. Serial. 1st part. No. 20689.

Laundry Machinery.

Steam Laundry Machinery. Sidney Tebbutt. Read before the Inst. of Mech. Engs., England. Part first considers briefly the arrangement of the laundry, and method of washing, but is largely a description of washing-machines. Ill. 4500 w. *Engng*—June 17, 1898. Serial. 1st part. No. 21184 A.

Liquefaction.

The Liquefaction of Hydrogen and Helium.

(Sur la Liquéfaction de Hydrogène et de l'Helium.) The original communication to the French Academy by Prof. Dewar, communicated by M. Moissan. 2400 w. Comptes Rendus—May 16, 1898. No. 21029 D.

Oil Testing.

Determination of the Value of Lubricants, Especially Spindle Oil, by a New Oil Tester. (Wertbestimmung von Schmierölen, besonders von Spindelölen, mit Einem Neuen Oelprüfer.) Dr. Sigmund Kapff. A loaded spindle is rotated by an electric motor, and the electric power required is used to measure the value of the lubricant. 3500 w. Zeitschr d Ver Deutscher Ing—May 14, 1898. No. 21037 D.

Rock-Crusher.

A Large Rock-Crusher and Crushing Plant. Describes a very large machine put upon the market by the Gates Iron Works, of Chicago. It has a capacity of 200 tons per hour. Also gives a record from the president of the Pittsburgh Limestone Co. of 14 months work. Ill. 1000 w. Eng News—June 16, 1898. No. 20881.

Rubber.

The Reclaiming of Old Rubber. Hawthorne Hill. An account of the progress made in reclaiming rubber from worn-out goods in a condition fit for use again, with information concerning the product. 3700 w. Sci Am Sup—June 25, 1898. No. 20995.

Artillery.

Cannon of Large Calibre. (Canons de Gros Calibre.) A discussion of the value of guns of various calibre as shown in the recent Spanish-American naval engagement at Manila. 1800 w. La Revue Technique—June 10, 1898. No. 21021 D.

Battleship.

H. M. S. Albion. Illustrated description of a vessel recently launched, with her equipment. 800 w. Engr, Lond—June 17, 1898. No. 21187 A.

Wanted: Faster Battleships. Editorial protest against the action of the Board of Construction of the Navy Department in deciding that the three new battleships provided for by the U. S. Congress should have speeds of only 15 or 16 knots. Also reviews the fast battleships of foreign nations. 2800 w. Eng News—June 23, 1898. No. 21120.

Camp Equipments.

New Camp Equipments for the German Army. From *Illustrirte Zeitung*. Cooking tent and its furnishings, stable tent, hospital appliances, officers' tents, &c., are illustrated. 500 w. Sci Am Sup—June 13, 1898. No. 20867.

Cruiser.

Recent Trials of the Cruiser "Diadem." John Durston. Report of the trials and their results which show that the engines and boilers are economical and efficient for warship service.

Stamp Mill.

Morison's Quick-Running Stamp Mill. Illustrated description. 900 w. Engng—June 3, 1898. No. 20831 A.

Standards.

Uniformity of Standard. John A. Grier. Showing the importance and convenience of a standard of weights and measures, and of other standards used in business. 2000 w. Prac Eng—June 3, 1898. No. 20739 A.

Thermodynamics.

A New Method for the Determination of the Mechanical Equivalent of Heat. (Methode Nouvelle pour Determiner l'Equivalent Mécanique de la Chaleur.) A method by MM. Baille and Féry, in which the elevation in temperature is measured of a metallic mass fixed in an alternating electrical field. 1000 w. Comptes Rendus—May 23, 1898. No. 21031 D.

Wire Rope.

Impact Tests on Wire Rope. Charles F. Hamilton. Describes tests and comparison with tensile strengths. 800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21128 D.

Wood Screws.

Experiments and Study upon the Holding Power of Wood Screws. Norris M. Works. Reports a series of experimental tests and the conclusions. 2000 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21126 D.

MILITARY ENGINEERING.

Discussion. 4800 w. Jour Am Soc of Naval Engs—May, 1898. No. 20685 H.

The Boilers and Bulkhead Doors of the "Chicago." Illustrated description of the changes made in this vessel to convert her into a fast cruiser, with special attention to the system for closing the bulkhead doors in an emergency. 1500 w. Sci Am—June 25, 1898. No. 20993.

The Chilean Cruiser "O'Higgins." Illustration with important particulars of this recently completed vessel. 800 w. Engng—May 27, 1898. No. 20709 A.

The Japanese Cruiser Takasago. Illustrated description of the latest development of second-class cruiser, as regards armament and propelling machinery. A noticeable feature is the absence of excessive superstructure and the very modest proportion of cowls. 700 w. Engr, Lond—June 3, 1898. No. 20827 A.

The Machinery of H. M. S. "Europa." Illustrates and describes the main propelling engines and other machinery, giving an account of her official steam trials. 2700 w. Engng—June 10, 1898. No. 20956 A.

Trials of Dutch Cruisers. Gives results of trials of three vessels of the Dutch navy, which were fitted with a combination of small tube, or express water-tube boilers and return tube boilers, giving also details of the vessels. 800 w. Engng—June 3, 1898. No. 20833 A.

Explosives.

Submarine Mines. George N. Crouse. De-

scribes the construction and operation and their effects. The best methods for harbor protection and the requirements. Ill. 2000 w. Yale Sci M—June, 1898. No. 20901 C.

Field Telephones.

See Electrical Engineering, Telephony.

Guns.

Our New Thirteen-Inch Guns. Illustrates and describes this gun, twenty-eight being in use in the U. S. navy. 1200 w. Sci Am—June 11, 1898. No. 20745.

Vickers' Guns. Illustrated description of the breech mechanism of guns manufactured by Messrs. Vickers, Sons, and Maxim, Limited, England. 2500 w. Engng—May 20, 1898. No. 20580 A.

Japanese Navy.

The Sea Power of Japan. Comments on the relation of Japan to the other Powers, her progress, and her aim to possess a strong enough fleet to guarantee against attack. A brief review of the present navy is given; with ships now building. 2400 w. Engng—May 20, 1898. No. 20583 A.

"Maine."

The Destruction of the United States Battleship "Maine." J. T. Bucknill. An examination and criticism of the work of the Court of Inquiry, with the aim of arriving at the truth concerning the disaster. 2100 w. Engng—May 27, 1898. Serial. 1st part. No. 20708 A.

Mining.

Rapid Mining System for Defense of Fortifications. (Nouveau Procédé de Construction Rapide des Galeries de Mines pour la Défense des Forteresses.) A form of portable wooden shield is used to enable military tunneling to be rapidly and successfully done. 1500 w. 1 plate. Le Génie Civil—June 11, 1898. No. 21009 D.

Sea Power.

Sea Power at the End of the Nineteenth Century. W. Laird Clowes. A full discussion of the various factors included in sea power, showing above all things the supreme importance of

speed. 5000 w. Engineering Magazine—July, 1898. No. 21230 B.

Smokeless Powder.

Smokeless Powder. Editorial, calling attention to the disadvantages the American navy have to contend with from not being provided with smokeless powder. 1000 w. Sci Am—June 11, 1898. No. 20744.

The Maxim-Schüpphaus Smokeless Powder. Some further information concerning this powder and its method of combustion. Ill. 3500 w. Engng—June 10, 1898. No. 20958 A.

Torpedo Boats.

The Submarine Torpedo Boat Plunger. J. Alvah Scott. Illustrated description of the boat and its equipment. 3000 w. Jour of Am Soc of Naval Engns—May, 1898. No. 20679 H.

The U. S. Torpedo Boat "Morris." H. G. Gillmer and M. A. Anderson. Description with report of trial. 1700 w. Jour Am Soc of Naval Engns—May, 1898. No. 20688 H.

The United States Torpedo Boats "Talbot" and "Gwin." M. A. Anderson and H. G. Gillmor. Description with dimensions and report of trials. 2000 w. Am Soc of Naval Engns—May, 1898. No. 20687 H.

Torpedo Tubes.

Torpedo Discharge Tubes. A report and description recently prepared by Sir William Armstrong, Whitworth & Co. of their new torpedo discharge tube. Ill. 2500 w. Engr, Lond—May 27, 1898. No. 20704 A.

U. S. Navy.

The Navy of the United States. Henry W. Raymond. Reviews the fighting capacity of the naval force, and considers the different classes in detail, with interesting comments. Ill. 3000 w. Chau—June, 1898. No. 20548 C.

War Operations.

The Conduct of the War. Gives a leading article from the London *Engineer*, containing comments and criticisms of the military and naval operations of the war between the U. S. and Spain, with editorial reply. 3500 w. Eng News—June 16, 1898. No. 20879.

MINING AND METALLURGY.

COAL AND COKE.

Cape Breton.

Notes on the Recent Discovery of Coal near Cochrane's Lake, C. B. E. T. Moseley. An address before the Mining Society of Nova Scotia. An estimated addition of one-thousand millions tons of coal. 1800 w. Can Min Rev—May, 1898. No. 20595 B.

Coal Cutting.

Coal Cutting by Machinery. W. T. Goolden. Read before the Fed. Inst. of Min. Engs., England. Abstract with discussion. Shows that a greater variety of machines are needed to meet special conditions. From the electrical system. 4700 w. Ir & Coal Trds Rev—May 27, 1898. No. 20697 A.

Coal Mines.

The Mines of the Consolidation Coal Company. Illustrated description of the mines of this company of Baltimore, Md., and its transportation facilities. 2000 w. Ir & Coal Trds Rev—June 10, 1898. No. 20954 A.

Coal Supply.

Coal in the East. From the *Statist*. Calls attention to the new coal seams being opened in China, Chili, Siberia, etc., and the changes being wrought by their discovery. 1600 w. Engr, Lond—June 10, 1898. No. 20968 A.

Contraband.

Coal as Contraband of War. Gives information of jurists and others respecting contraband of war generally, and the penalty of carrying it,

with some discussion of the decision regarding coal, as given by the English Home Secretary to the Lords of the Admiralty. 2800 w. Col Guard—May 20, 1898. No. 20589 A.

Durham.

Impressions of Durham Coal Mining on a Lancashire Man. Arthur Mort. Notes on the mining practice in this district, the result of a recent visit. 2800 w. Col Guard—May 27, 1898. No. 20715 A.

El Paso.

The El Paso Coal Field. Arthur Lakes. Report on a new and valuable coal field near Colorado Springs, Colorado. Ill. 1400 w. Mines & Min—June, 1898. No. 20722 C.

Storage.

Coal Storage. Charles Piez. The different methods of storing and handling the steam sizes of anthracite coal. The reasons for storage, describing the advantages and disadvantages of the various systems in use, and the cost of operating and constructing them. Ill. 3500 w. Mines & Min—June, 1898. No. 20723 C.

COPPER.

Copper Field.

Chillagoe, Queensland, Australia. Interesting particulars of this great copper field. 1500 w. Aust Min Stand—May 12, 1898. No. 21207 B.

Copper-Mattes.

The Elimination of Impurities of Copper-Mattes in the Reverberatory and Converter. Edward Keller. Discussion of this paper presented at the Atlantic City Meeting, Feb., 1898. 1500 w. Trans of Am Inst of Min Eng—June, 1898. No. 21142 D.

Electrolytic Assay.

The Electrolytic Assay as Applied to Refined Copper. Additional discussion of George L. Heath's paper, presented at the Lake Superior meeting, July, 1897. 2800 w. Trans Am Inst of Min Eng—June, 1898. No. 21140 D.

Production.

Copper Production in 1897. The output in the United States, reached the highest point ever attained. 900 w. Eng & Min Jour—June 25, 1898. No. 21169.

GOLD AND SILVER.

Alluvial Mining.

Alluvial Gold Mining at Edmonton, Alberta, Canada. Isaac Cowie. An account of the mineral wealth of this region, the methods of mining employed, and general information of interest. 3400 w. Can Min Rev—May, 1898. No. 20594 B.

Assays.

Scorification and Cupellation Without Muffle.—A New Furnace and Method for Gold and Silver Assays. George A. Koenig. Describes a new departure in assaying, the furnace used, and the process. Ill. 5800 w. Trans of Am Inst of Min Eng—June, 1898. No. 21147 D.

Auriferous Lodes.

The Genesis of Certain Auriferous Lodes.

Discussion of the paper by Dr. John R. Don, presented at the Chicago meeting, Feb., 1897. 4500 w. Trans of Am Inst of Min Eng—June, 1898. No. 21139 D.

British Columbia.

British Columbia Mines in 1897. William A. Carlyle. An interesting report of this region showing the gratifying progress and steady growth. 3300 w. Eng & Min Jour—June 4, 1898. No. 20654.

Mining and Transportation. William M. Brewer. Some of the methods practiced in British Columbia and the conditions of geography and climate which necessitate them. 1800 w. Mines & Min—June, 1898. No. 20727 C.

The Sardon District. W. M. Brewer. Brief review of the mines of this district in British Columbia. 1800 w. Eng & Min Jour—June 18, 1898. No. 20946.

Cassel-Hinman Process.

The Cassel-Hinman Gold and Bromine Recovery Process. Editorial discussion of this new process, considering especially its feasibility from a metallurgical point of view. Thinks the statements made by the company need careful investigation before meriting the attention of investors. 1800 w. Eng & Min Jour—June 18, 1898. No. 20944.

Colombia.

Gold in the Vicinity of Barbacoas. (L'Or aux Environs de Barbacoas.) Describing the gold washings at Barbacoas, in the State of Cauca, Colombia, at present very imperfectly worked by the natives, but present excellent possibilities. 2500 w. La Revue Technique—June 10, 1898. No. 21023 D.

Colorado.

Colorado Ore Market. From the report of the State mine commissioner. Relating to the methods pursued for the determination of values contained in ores. 1800 w. Min & Sci Press—May 28, 1898. No. 20628.

Crushing.

Sectional Cushioned Rolls. Joseph William Pinder. Describes a system for increasing the efficiency in crushing. Ill. 600 w. Trans of Am Inst of Min Eng—June, 1898. No. 21144 D.

Cyanid Process.

Some Notes on the Recovery of Gold from Cyanid Solutions. S. C. Coles. Read before the Inst. of Min. and Met. Gives results obtained from gold cyanid solutions of varying strengths with aluminum cathodes and iron anodes. 1800 w. Min & Sci Pr—June 11, 1898. No. 20870.

The Stamp Milling of Gold Ore in Its Relation to Cyaniding. E. H. Johnson. A continued discussion of this paper. 6500 w. Jour of Chem & Met Soc of S. Africa—April, 1898. No. 20925 E.

The Cyanid Process as Applied on the Rand. W. Leonard Holms. A fully illustrated account of the working of the low grade ores of the Witwatersrand by the cyanid process, with many practical details. 3500 w. Engineering Magazine—July, 1898. No. 21234 B.

Furnace Construction.

Silver Lead Blast Furnace Construction. H. V. Croll. Notes based on observations of the construction and improvements in the smelting practice of Colorado and Utah, reviewing the progress. 1900 w. Eng & Min Jour—May 28, 1898. No. 20560.

Goldfields.

The Goldfields of British Columbia and the Klondike. William Hamilton Merritt. Deals with the immense possibilities of the mountain ranges of Western British America, giving a very interesting report of the region and the mining operations. Discussion. 8000 w. Jour Soc of Arts—June 10, 1898. No. 20922 A.

Mexican Mines.

Some Mines in Sonora, Mexico. E. T. Dumble. An account of this region, the abandoned properties and working mines, with the opinion that it is destined to become a very active mining region. 1600 w. Eng & Min Jour—June 18, 1898. No. 20945.

New South Wales.

Gold and Tellurides at Cooma, New South Wales. J. E. Carne. A report of this field, furnished to the Department of Mines. 3000 w. Aust Min Stand—May 5, 1898. No. 20720 B.

New Zealand.

The Gold Mines of New Zealand. (Les Mines d'Or de la Nouvelle-Zélande.) A general description, with photographic views, and a geological map of the district of Hauraki. 2000 w. Le Génie Civil—June 11, 1898. No. 21008 D.

Ore Deposits.

Indications of Ore Deposits. E. Lidgley. Some of the indications in various places that lead a prospector to know whether he is on the right track of a lode, reef, or ore deposit. 2000 w. Aust Min Stand—May 5, 1898. Serial. 1st part. No. 20719 B.

Ores.

Ore Occurrence in the Red Mountain District, Colorado. Arthur Lakes. Some of its peculiarities and the causes of them. 2300 w. Mines & Min—June, 1898. No. 20729 C.

Ore Washers.

An Apparatus for the Removal of Sand from the Waste Water of Ore Washers. J. E. Johnson, Jr. Discussion of this paper, presented at the Atlantic City meeting, Feb., 1898. 900 w. Trans of Am Inst of Min Engs—June, 1898. No. 21143 D.

Peculiar Formation.

A Peculiar Lode Formation. C. E. Willis. Read before the Mining Society of Nova Scotia. Illustrated description of a discovery in Nova Scotia. 700 w. Can Min Rev—May, 1898. No. 20596 B.

Philippines.

Notes on the Philippine Islands. Extracts from a pamphlet by Frank Karuth, entitled "A New Center of Gold Production," describing conditions in the Philippines. 5800 w. Cons Repts, No. 131—June 3, 1898. No. 20634 D.

Rapid Sinking.

Rapid Sinking in a Nova Scotia Gold Mine. A. A. Hayward. Read before the Mining Society of Nova Scotia. Facts from the experience of the writer aiming to show that the best possible results are not being obtained in that community by the methods used. 3500 w. Can Min Rev—May, 1898. No. 20597 B.

Smelting.

Pyritic Smelting and Its Bearing on Certain South African Ores. D. Dörrfel. Refers to the two ways of disposing of ores of this character, and some points of importance in pyritic smelting. 2000 w. Jour of Chem & Met Soc of S Africa—April, 1898. No. 20694 E.

Stamp Mills.

Stamp-Mill Indicator Diagrams. Henry Louis. Describes a method, devised by D. B. Morison, of analyzing the action of the ordinary gravity stamp, which has given light on the exact motion of the stamp-head, and promises to be of value in determining the efficiency of a new mill before setting it to its work. 2000 w. Trans of Am Inst of Min Engs—June, 1898. No. 21137 D.

Sulphides.

The Broken Hill Sulphide Problem. Remarks based on information obtained from William Dewar, on the system adopted at Broken Hill, giving a brief account of a plant designed by one of the larger companies. 1700 w. Eng & Min Jour—June 4, 1898. No. 20653.

Veins.

Notes on the Vein-Formation and Mining of Gilpin County, Colorado. Forbes Rickard. Describes the district, the formation, ore deposits, veins, &c. Ill. 4800 w. Trans of Am Inst of Min Engs. June, 1898. No. 21148 D.

IRON AND STEEL.

Basic Steel.

Basic Refined Steel on the Continent. C. E. Stromeier. Read at the Inst. of Engs. and Shipbuilders in Scotland. Discusses the three processes of basic steel in some detail and aims to show that what the writer calls basic refined steel is a material surpassing that produced in the acid open-hearth. 5800 w. Engng—June 17, 1898. No. 21185 A.

The Rolling of Thomas Steel. (Le Laminage de l'Acier Thomas.) J. Magery. A description of the rolling mills of the basic steel plant at Roth-Erde, near Aix-la-Chapelle. 2500 w. Revue Universelle des Mines—May, 1898. No. 21094 H.

Bertrand-Thiel.

Notes on the Bertrand-Thiel Process. James Hartshorne. Showing the developments of this process and the results. Gives a brief résumé of what has been recently published on this subject. 3800 w. Trans of Am Inst of Min Engs—June, 1898. No. 21138 D.

Blast Furnaces.

Management of Blast Furnaces—Transition from "Rule of Thumb" to Application of Sci-

entific Methods. E. S. Cook. An account of the writer's experience, discussing furnaces, fluxing, fuel, ores, limestone, pig iron, furnace management, modern construction, &c. 10500 w. Sch of Mines Quar—April, 1898. No. 20666 D.

The Heat Balance of the Blast Furnace. (L'Equilibre Calorifique du Haut-Fourneau). G. Rocour. A discussion of the thermal interchanges which take place in the smelting of iron, with examples of the method of computing the thermal efficiency of the blast furnace. 12000 w. 3 plates. Revue Universelle des Mines—April, 1898. No. 21092 H.

By-products.

A By-product of Iron Making. William Gilbert Irwin. Reports the discovery of a method for utilizing iron slag. The product is called carbollite, and from it is produced ethylene gas which is a great improvement over acetylene. 1200 w. Sci Am—June 25, 1898. No. 20994.

Cementation Process.

On the Passage of Carbon into Iron during the Cementation Process. George J. Pitt. Read before the South Staffordshire Inst. of Iron and Steel Works Managers. Gives a detailed account of experimental study which seems to indicate that molecular interchange is the explanation of the mode in which the carbon passes into the iron in this process. 2500 w. Col Guard—June 10, 1898. No. 20963 A.

Chromic Iron.

Chromic Iron in Canada. The facts presented are from a recent report by J. Obalski, inspector of mines for Quebec. Its use in the chemical industries, and facts relating to the deposits. 1600 w. Can Engr—June, 1898. No. 20785.

Hodbarrow Mines.

The Hodbarrow Hematite Iron Ore Mines. Information of these deposits which, until the discovery of the Lake Superior mines, turned out a greater tonnage than any other iron mine in the world. The location of the deposit adds to the difficulties in working. 900 w. Col Guard—June 3, 1898. No. 20838 A.

Iron Trade.

See Economics and Industry, Commerce and Trade.

Malleable Iron.

Malleable Iron in Car Construction. R. M. Galbraith. Showing that economy is secured in its use, but that there is great difference in the quality, and that the design of patterns is important. 1300 w. R R Car Jour—June, 1898. No. 20789.

The Use of Malleable Iron In Car Construction. Drawings and description with tests of a malleable iron bolster. 1000 w. Loc Engng—June, 1898. No. 20692 C.

Mesabi Range.

Sketch of the Geology of the Eastern End of the Mesabi Iron Range in Minnesota. U. S. Grant. Information of the physical features, geology, iron ore, &c. Map. 4200 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20661 E.

Micrography.

The Micro-Structure of Iron and Steel. S. S. Knight. Read at Cincinnati meeting of the Am. Foundrymen's Assn. Showing the benefits to be derived from the use of the microscope in this field. Ill. 5000 w. Am Mfr & Ir Wld—June 17, 1898. No. 20926.

Pig Iron.

Sampling Pig Iron for Analysis. Albert Ladd Colby. A discussion of the methods of sampling pig iron with the object of showing how accuracy can be obtained without unnecessary complications. 5500 w. Ir Age—June 2, 1898. No. 20620.

Slag Bricks.

Slag Bricks in Germany. Information concerning the bricks made from granulated slag, and their superiority to bricks made of fluid slag. 700 w. Cons Repts, No. 144—June 18, 1898. No. 20923 D.

Steel Plant.

The Alabama Steel Plant. A. M. Shook. Relates to the large steel plant to be built by the Tennessee Coal, Iron and Railroad Co; at Ensley, Ala. 1400 w. Ir Age—June 23, 1898. No. 20997.

Steel Testing.

Progress in the Study of Steel. (Les Progrès Réalisés dans la Connaissance du Métal Acier.) Ad. Greiner. A discussion of the various methods of testing steel, and giving especial attention to peculiarities of physical constitution as revealed by metallography and microscopy. 5000 w. Revue Universelle des Mines—May, 1898. No. 21093 H.

Steel Works.

See Mechanical Engineering, Shop & Foundry.

Testing.

The Practical Aspect of Present Commercial Methods of Testing Iron and Steel. P. Kreuzpointner. Explains the economic necessities that have made the testing, inspecting and analyzing of materials so important, and discusses the methods used. Discussion. 7800 w. Jour Fr Inst—June, 1898. No. 20669 D.

Tropenas Steel.

Notes on the Tropenas Steel Process. Alexander Tropenas. Read at the Cincinnati meeting of the Am. Foundrymen's Assn. Gives description of plant operation, quality of metal, &c., with cost. 4000 w. Ir Age—June 16, 1898. No. 20860.

MINING.

Accident.

Report on the Snaefell Lead Mine Accident. Abstract of report of C. Le Neve Foster on the circumstances attending the underground fire at the Snaefell lead mine in the month of May, 1897. 7000 w. Col Guard—June 3, 1898. No. 20837 A.

Blasting.

The Permitted Safety Gunpowder Cartridge for Coal Mines. Donald M. Stuart. Résumé

of a paper on this subject, at meeting of Colliery Managers' Assn., England. It describes the conditions required in a safe explosion, and claims this cartridge meets the requirements, reporting trials, &c. 900 w. Col Guard—June 17, 1898. No. 21179 A.

Boring.

Boring in Mines. T. Railton. Notes of a lecture delivered to mining students at Abercynon. Results from the experience of the writer, dealing with methods and different classes of work in boring. 2500 w. Col Guard—May 20, 1898. No. 20588 A.

Drilling.

Mechanical Rock-Drilling in Mines. M. J. Kersten. Describes various types of rock-drills, and methods of working them. Ill. 2700 w. Col Guard—June 3, 1898. No. 20836 A.

Dynamite.

Some Notes on the Mechanical Tests, Uses, Effects and History of Dynamite. Arthur Edwin Haynes. An interesting discussion of this powerful agent and the uses made of it. 3000 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20659 E.

Explosion.

A Dust Explosion. David Griffiths. A peculiar explosion on a tippie at the Crested Butte Mine, Colorado. 900 w. Mines & Min—June, 1898. No. 20726 C.

Explosives.

Experiments with Safety Explosives. From *Mining Engineering*. The results of some of the latest German experiments and deductions therefrom. 1500 w. Mines & Min—June, 1898. No. 20725 C.

On the Various Systems of High Explosives and the Conditions of Their Economical Application to the Different Methods of Coal-Working in British Collieries. John Heath. Special prize essay. An account of experiments is given in part first. 3000 w. Ir & Coal Trds Rev—June 3, 1898. Serial. 1st part. No. 20839 A.

Firedamp.

Ignition of Firedamp and Coaldust by Electricity. Heise and Theim in *Zeit für Angewandte Chemie*. Detailed conclusions deduced from experiments made by the writers. 700 w. Col Guard—June 10, 1898. No. 20961 A.

Haulage.

An Overland Cable Haulage Installation at the Monceau-Fontaine Collieries. Translated from the *Annales des Mines de Belgique*. Describes the Dinnendahl system of haulage, giving cost of installation. Ill. 900 w. Ir & Coal Trds Rev—June 3, 1898. No. 20840 A.

Hoisting Plant.

Arrangement of a Mine Hoisting Plant. (Zusammenstellung der bei Anlage von Streckenförderanlagen zu Berücksichtigenden Punkte.) A very full discussion of the most economical arrangement for certain given conditions, including the use of an electric motor winding engine. 5000 w. 2 plates. Glückauf—May 21, 1898. No. 21099 B.

Mine Air.

Mine Air Analysis and Firedamp Detection. M. S. Chesneau. From a communication to the International Congress of Applied Chemistry. Shows the importance of analyzing the air of mines, and discusses the methods used in France for the determination of firedamp. 3000 w. Col Guard—May 20, 1898. No. 20585 A.

Mine Ventilation.

Theory of the Equivalent Orifice. M. Lafitte. From a communication to the Société de l'Industrie Minérale, Sainte Etienne. An adaptation of Guibal's theory of moduli to the notion of the equivalent orifice due to M. Murque, and generally adopted on account of the convenient representation it affords of a mine's resistance. 1200 w. Col Guard—June 17, 1898. No. 21180 A.

Mining Industry.

The Mining Industry, and the Relation of the Federal Government to it Through the Work of the Different Departments. E. W. Parker. Considers briefly the different bureaux each of which deals with mining matters from a different standpoint. 3000 w. Mines & Min—June, 1898. No. 20728 C.

Ore Reserves.

Calculating Value of Ore Reserves. John Cline Little. Abstract of paper in the *Journal of the British Association of Mining Students*. Gives a diagram for estimating ore in sight, and offers suggestions for the speedy manipulation of figures that may result from careful measuring and sampling. 1700 w. Eng & Min Jour—June 25, 1898. No. 21171.

Pit Props.

The Strength of Pit Props. H. Louis. Abstract of paper read before the Fed. Inst. of Min. Engs., England. Researches confined to the initial strength of the prop when ready for setting. Gives results of experiments. 2800 w. Ir & Coal Trds Rev—May 27, 1898. No. 20698 A.

Progress.

Twenty Years' Mining Progress. James T. Forgie. Abstract of a presidential address delivered before the Mining Inst. of Scotland. Reviews the marked progress in Great Britain and especially in Scotland. 3200 w. Col Guard—June 17, 1898. No. 21181 A.

Reports.

Reports of the Inspectors of Mines for 1897. Gives reports of the Liverpool district, Durham district, and Newcastle district. 1500 w. Col Guard—May 20, 1898. No. 20586 A.

Safety Lamp.

Firedamp-Indicating Lamp. M. G. Chesneau. From a communication to the Second International Congress of Applied Chemistry. Particulars of this appliance based on the results of active practice, as more than 400 are in service. Ill. 3500 w. Col. Guard—May 27, 1898. No. 20714 A.

Shafts.

Sinking and Equipping Deep Winding Shafts.

E. Tomson. From a communication to the jubilee meeting of the Liege Engineers' Assn. Gives results of the writer's studies for laying out of Preussen No. 1 for depth of working from 400 m. to 800 m., and Preussen No. 2, for 450 m. to 1000 m. Ill. 3900 w. Col Guard—June 10, 1898. No. 20959 A.

Sinking the Maypole Shafts Near Wigan. James Keen. Abstract of a lecture delivered at the Wigan Mining School. An interesting description of the work as far as it has progressed. 4000 w. Col Guard—May 20, 1898. No. 20584 A.

Surveying.

A Contribution to Mine Surveying. Bergrath Brathuhn in *Berg- und Hüttenmännische Zeitung*. Explains the determining the depth of perpendicular shafts by the aid of a measuring wheel, determining the perpendicular by the aid of an inscribing plummet, and other measurements. 2200 w. Col Guard—May 20, 1898. No. 20587 A.

Winding.

Improvements in Winding Appliances. E. M. Hann. Read before the South Wales Inst. of Engs. Illustrated description of some practical improvements made in existing plants, with some suggestions for further improvements. 2200 w. Col. Guard—June 17, 1898. No. 21177 A.

MISCELLANY.

Alloys.

Mechanical Properties of Certain Aluminum Alloys. R. C. Carpenter. Facts that have been definitely determined during investigations carried on at the laboratories of Sibley College, Cornell University. 3700 w. Am Soc of Mech Engs, No. 784—June, 1898. No. 20755 D.

The Constitution of Ternary Alloys. (*Sur la Constitution des Alliages Ternaires.*) Georges Charpy. A micrographic examination of alloys of lead, tin, and bismuth, showing how the different constituents are arranged in the alloy. 1500 w. Comptes Rendus—June 6, 1898. No. 21033 D.

Asbestos.

Asbestos. Paul Kersting. Communication from the Laboratory of the Royal Technical High School, at Berlin. The properties of this substance, where principally found, the varieties, with analyses. 1800 w. Am Mfr & Ir Wld—June 3, 1898. No. 20695.

Caucasus.

Notes on the Geological Structure of the Caucasus Range Along the Georgia Military Road. Dr. Persifor Frazer. Notes on the formation, based mainly on the labors of the Russian Geological Survey. 1300 w. Trans of Am Inst of Min Engs—June, 1898. No. 21141 D.

Fluorine.

The Fluorine Mine. Arthur Lakes. An illustrated description of a geological puzzle furnished by the formations on Copper mountain near Cripple Creek. Discusses the practical bearing of the solution of such questions upon

mining development, and how a correct solution prevents needless waste of time and money. 3300 w. Mines & Min—June, 1898. No. 20724 C.

High Temperatures.

Aluminum for High Temperatures and for the Reduction of Metals from their Oxides. J. B. Nau. Describes the method of Hans Goldschmidt for the extraction of metals from their oxides by means of metallic aluminum. 2000 w. Ir Age—June 16, 1898. No. 20855.

A New Method of Generating High Temperatures. (*Ueber ein Neues Verfahren zur Erzeugung Hoher Temperaturen.*) Dr. H. Goldschmidt. The process is based on the fact the aluminum develops a high temperature in entering into combination, and hence raises the temperature when used as a reducing agent. 3000 w. Stahl und Eisen—May 15, 1898. No. 21072 D.

Joplin, Mo.

Lead and Zinc Milling and Concentrating in the Joplin, Mo., District. E. Hedburg. The primitive mode procedure and the latest modern plants, showing the different systems in use in its several stages for the different classes of ores. Ill. 2000 w. Mines & Min—June, 1898. No. 20721 C.

Manganese.

The Manganese-Ore Industry of the Caucasus. Frank Drake. Mainly descriptive of the manganese district of Chiaturi, the location and topography, the deposits and their characteristics, methods and cost of mining, etc. Ill. 3600 w. Trans of Am Inst of Min Engs—June, 1898. No. 21146 D.

Metal Working.

Limitations of Milling in Metal Working. John Richards. Tracing some of the conditions and limitations, as far as proved by common practice. 1200 w. Am Mach—June 16, 1898. No. 20862.

Mica.

Mica Mining in the District of Nellore, India. Robert W. Thompson. Describes the region, the deposit, and matters relating to the industry. As the deposit is near the surface the method of working is mere quarrying. The cutting and sorting is of great importance. 2000 w. Jour Soc of Arts—June 17, 1898. No. 21191 A.

Minerals.

United States Mineral Production in 1897. Statistics of the production of minerals and metals in the United States, as arranged for "The Mineral Industry." 4500 w. Eng & Min Jour—May 28, 1898. No. 20559.

New Caledonia.

Mineral Resources of New Caledonia. Henry W. Edwards. An account of the geology and minerals of this island of the South Pacific, with report of conditions of labor, mining operations and processes used in the treatment of the ores. Ill. 3000 w. Eng & Min Jour—May 28, 1898. No. 20561.

Newfoundland.

Mining in Newfoundland. James P. How-

ley. A letter containing statistics of the mineral development, and giving an account of the progress and present standing of this industry. 1200 w. Can Min Rev—May, 1898. No. 20593 B.

Nickel.

The Occurrence and Production of Nickel. Perry F. Nursey. Particulars respecting the occurrence and production in the United States. 2500 w. Ind & Ir—June 10, 1898. No. 20953 A.

Nickel Alloys.

The Microstructure of Alloys of Iron and Nickel. (Sur la Microstructure des Alliages de Fer et de Nickel.) A preliminary note by M. Osmond, giving the micrographic classification of the nickel-iron alloys up to 50 per cent. of nickel. 1000 w. Comptes Rendus—May 9, 1898. No. 21027 D.

Oil Field.

The Recently Developed Oil Field of Texas. Thomas D. Miller. Paper presented to the Eng's Club of St. Louis. All the petroleum in Texas yet examined has an asphaltum base. An account of the oil-producing field, the production and quality. 1000 w. Eng & Min Jour—June 18, 1898. No. 20948.

Petroleum.

The Manufacture of Illuminating Oil at Baku in 1897. W. Latkin. Report of the production, methods used, quality, etc. 1400 w. Am Mfr & Ir Wld—June 24, 1898. No. 21220.

Reconnaissance.

Notes of a Reconnaissance from Springfield, Mo., into Arkansas. E. J. Schmitz. An in-

spection of the zinc, lead, and other resources of this region, and a rapid view of the topography. 2300 w. Trans of Am Inst of Min Engs—June, 1898. No. 21145 D.

Respirator.

Comparative Tests of the Neupert Respirator and the Walcher Gärtner Pneumatophor. (Versuche mit O. Neupert's Rettungsapparat, nebst einem Vergleichenden Versuch mit dem Walcher-Gärtner'schen Pneumatophor.) R. Heller. The tests were made for periods of two hours at a time, and demonstrated that the oxygen in the air could be replaced, and the carbonic acid removed satisfactorily. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 21, 1898. No. 21098 B.

Russia.

Geological Excursion Through Southern Russia. S. F. Emmons. Presents some features of the trip of interest to the mining engineer and geologist. Ill. 7400 w. Trans of Am Inst of Min Engs—June, 1898. No. 21135 D.

Smelting.

Electric Smelting. W. S. Horry. Abstract of paper read before the Northwestern Electrical Assn. giving investigations made with electric smelting, and stating that there is every reason to expect great things from this method. 1300 w. Elec Wld—June 25, 1898. No. 21109.

The Possibilities for Smelting in British Columbia. R. A. Hedley. Read before the Fed. Can. Min. Inst. Information concerning the character of the ores and cost of smelting. 1400 w. Can Engr—June, 1898. No. 20787.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene Generators. Dr. N. Caro. Abstract translation of article in the *Zeitschrift für Beleuchtungswesen*. Considers the reactions by which acetylene is produced, the necessity of a gasholder, and how the generators devised for use stand with regard to the existing conditions. 2800 w. Jour Gas Lgt—June 14, 1898. No. 21104 A.

Apparatus for the Production of Acetylene Gas. Illustrates and describes the "Revolver" apparatus of the Société du Gaz Acetylene, and its operation, and the Reibel apparatus. Particulars and illustrations taken from *Le Genie Civil*. 2200 w. Sci Am Sup—June 18, 1898. No. 20866.

Professor Lewes on Acetylene Generators. Abstract of paper read at meeting of the London Section of the Society of Chemical Industry. Notes the especially dangerous impurities; discusses the existing types of generators; describing experiments made. 1400 w. Jour Gas Lgt—June 14, 1898. No. 21103 A.

The Acetylene Gas Exhibition. Perry F. Nursey. An account of the exhibition of acetylene gas apparatus and production in London. 6500 w. Ind & Ir—June 17, 1898. No. 21189 A.

The Purification of Acetylene. Shows the need of purification and briefly explains Dr. Wolff's scheme which is considered practical and efficient. 900 w. Jour Gas Lgt—June 14, 1898. No. 21101 A.

Address.

Presidential Address before the Institution of Gas Engineers, England. G. E. Stevenson. Reviews the events which have affected the gas industry of England during the last year, discusses the inclined-retort system, carbonizing plant, carburetted water-gas, &c. 5500 w. Jour of Gas Lgt—June 14, 1898. No. 20999 A.

Bench Firing.

Isolated Generators for Bench Firing. Extracts from letters of English gas engineers on this subject, with comments and discussion. 4300 w. Am Gas Lgt Jour—June 20, 1898. No. 20931.

Carbonizing.

A new Departure in Carbonizing, Having for its Objects the Prevention of Naphthalene Troubles and the Providing of Cheap Enrichment. S. and T. Glover. Read at meeting of Inc. Inst. of Gas Engs. Gives an account of the process adopted and measure of success attained. Discussion. 9500 w. Gas Wld—June 18, 1898. No. 21198 A.

The Carbonizing Plant of a Modern Gas-

Works. F. D. Marshall. Read at meeting of Inc. Inst. of Gas Engs. Describes the carbonizing plant of the Frederiksberg works of the Danish Gas Co., giving costs, working results, &c. Discussion. Ill. 10000 w. Gas Wld—June 18, 1898. No. 21195 A.

Convention.

Convention of the Technical Society of the Gas Industry in France. (Société Technique de l'Industrie du Gaz en France. Congrès de Nice.) A general report, with abstracts of the papers presented. 3000 w. Le Génie Civil—May 21, 28, 1898. Two articles. No. 21003 each D.

Decomposition.

The Decomposition of Gas Oil, Phenol, and Creosote by Heat. A summary of researches carried out by Dr. E. Müller at the Chemical Technical Inst. at Carlsruhe. Abstract translation from the *Journal für Gasbeleuchtung*. 2500 w. Jour Gas Lgt—June 7, 1898. Serial. 1st part. No. 20884 A.

Distribution.

High-Pressure System of Distribution. Fletcher W. Stevenson. Read at meeting of Inc. Inst. of Gas Engs. Describes this system as used at Sheffield, Eng. Discussion. 4800 w. Gas Wld—June 18, 1898. No. 21193 A.

Enrichment.

Enrichment of Coal Gas. George H. Harper. Read at Detroit meeting of the Western Gas Assn. A summary of what is known concerning this question, discussing the methods in general use. Followed by a contribution to the discussion by W. W. Goodwin, entitled "Enrichment of Coal Gas by Acetylene," and a general discussion. 11000 w. Pro Age—June 1, 1898. No. 20621.

Gas Analysis.

The Simple and Efficient Gas Analysis Apparatus. Dr. W. H. Birchmore. Describes and illustrates a simple and efficient apparatus, explaining the method of using. 1400 w. Am Gas Lgt Jour—June 27, 1898. No. 21218.

Gas Apparatus.

Washers and Scrubbers. Edward A. Harmon. Reviews the conditions under which gas is liberated and discusses the functions of washers and scrubbers, the object and the methods. Describes the various forms of apparatus. 10500 w. Gas Wld—June 18, 1898. No. 21199 A.

Gasholder.

The Three-Lift Gasholder at Sutton. F. S. Cripps. Illustrated description with remarks on the construction. 1700 w. Jour Gas Lgt—May 24, 1898. No. 20599 A.

Gas Liquors.

Methods of Estimating the Value of Gas Liquors. O. O. Thwing. Read at Detroit meeting of the Western Gas Assn. Deals with the volumetric test of ammoniacal liquors. Discussion. 5500 w. Pro Age—June 15, 1898. No. 20810.

Gas Prospects.

The Present and Future Prospects of Gas for Lighting, Heating and Power Purposes. Henry

R. Lordly. Discusses the impetus given the industry by the invention of the Welsbach burner, and other appliances for lighting, heating and motive power. Ill. 6500 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21129 D.

Gas Works.

Halifax Corporation Gas Works. Illustrated description of a new purifying house. 800 w. Engr, Lond—June 10, 1898. No. 20966 A.

Inflammability.

The Limits of Inflammability of Carbon Monoxide and Other Combustible Gases. H. Le Chatelier and Boudouard. Gives the results of investigations and calculations. 700 w. Col Guard—June 10, 1898. No. 20960 A.

London Gas.

The Gas Industry. Some interesting items relating to the manufacture of gas in London, taken from the last annual report. 1500 w. Builder—June 4, 1898. No. 20820 A.

Machinery.

Gas-Works Machinery. Edward A. Harmon. Read at meeting of London Soc. of Engs. Remarks on the special requirements for machinery in gas works, to meet the conditions, with a review of many of the mechanical appliances. 7500 w. Jour Gas Lgt—June 7, 1898. No. 20883 A.

Gas-Works Machinery. Discussion on paper by E. A. Harmon. 4500 w. Jour Gas Lgt—June 14, 1898. No. 21105 A.

Measurement.

Report upon the Temperature of Gas Measurement. Report, tables and diagrams of the sub-committee appointed by the Institution of Gas Engineers (London). 800 w. Gas Wld—June 4, 1898. No. 20822 A.

Standards of Light and Temperature of Gas Measurement. Discussion at meeting of the Incorporated Institution of Gas Engineers, England. 2300 w. Gas Wld—June 18, 1898. No. 21192 A.

Meters.

The Prepayment Meter. C. H. Raynor. Read at Detroit meeting of the Western Gas Assn. Reports the experiences of various companies using these meters, and the advantages of their use. Discussion. 7000 w. Pro Age—June 1, 1898. No. 20623.

Natural Gas.

The Discovery of Natural Gas in Sussex, England. An outline of investigations of C. Dawson and Dr. Hewett in regard to the utility of this gas, with an account of its discovery, and probable origin. 1800 w. Jour of Gas Lgt—June 14, 1898. No. 21100 A.

Ownership.

The Relation of the Gas Supply to the Public. John H. Gray. Reviews the history of the gas industry and considers that the only road to reform lies through legislation, by which the accounts and books of the companies shall be kept in a uniform manner and then given to the state and ultimately to the public. 4200 w. Munic Af—June, 1898. No. 20918 C.

Photometry.

Photometric Standards. W. Grafton. Gives experimental results in the hope of clearing up existing difficulties. Explains in part first what is meant by a standard light of a candle, and gives tests of candles to ascertain normal light. 2200 w. Jour Gas Lgt—June 14, 1898. Serial. 1st part. No. 21102 A.

Pintsch Gas.

The Pintsch Gas System of To-day. F. H. Shelton. Describes the Pintsch gas producing plant at Washington, D. C., as typical of the large number extending from the Atlantic to the Pacific, and gives interesting facts in connection with its extensive use in railway lighting. 2500 w. Am Gas Lgt Jour—May 30, 1898. No. 20558.

Purification.

Complete and Continuous Purification of Coal Gas in Closed Vessels Without Nuisance. Ernest J. Sutcliffe. Describes a method believed to be both feasible and practicable. The plan is a combination of the system of milk or cream of lime purification, and of the Claus sulphur recovery process. 2700 w. Jour Gas Lgt—May 31, 1898. No. 20737 A.

Retorts.

Hindrance to the Adoption of the Inclined Retort in America. Frederick Equer. Read at Detroit meeting of the Western Gas Assn. Presents the advantages and economy to be gained. Discussion. 3500 w. Pro Age—June 15, 1898. No. 20811.

The Construction and Working of Inclined Retorts. E. Drory. Read at meeting of Inc. Inst. of Gas Eng. The writer's experience of nine years, dealing with the construction and working of inclined retorts. 2800 w. Gas Wld—June 18, 1898. No. 21194 A.

Self-Lighters.

Recent Progress in Self Lighters for Incandescent Lamps. M. Syssoeff. Abstract of a paper read before the "Société Technique de l'Industrie du Gaz en France." Reviews the attempts that have been made to solve this problem and reports highly satisfactory results obtained in lighting gas by chemical reaction. 2000 w. Pro Age—June 15, 1898. No. 20812.

Standard Lamp.

A Two-Candle Pentane Standard. E. Llewellyn Pryce. Read at meeting of Inc. Inst. of Gas Eng. Describes the Simmance 2-candle standard, which is a modification of Harcourt's portable pentane lamp. Discussion. 9300 w. Gas Wld—June 18, 1898. No. 21197 A.

The Pentane Ten-Candle Standard Lamp. A. Vernon Harcourt. Read at meeting of the Inc. Inst. of Gas Eng. An account of this lamp and the improvement made, manner of adjusting, etc. 2300 w. Gas Wld—June 18, 1898. No. 21196 A.

Testing.

The Revised Instructions of the Metropolitan Gas Referees. The portions in which changes have been made in the new instructions in regard to the testing of gas which have been prepared by the Metropolitan Gas Referees, London.

8000 w. Jour Gas Lgt—May 31, 1898. No. 20738 A.

Texas.

Recent Developments in Texas. Thomas D. Miller. Gives a brief historical sketch of the gas industry in the state, the coals used, &c. Discussion. 2800 w. Pro Age—June 1, 1898. No. 20624.

Use of Gas.

The Use of Gas for Purposes Other Than Lighting. C. W. Blodget. Read at Detroit meeting of the Western Gas Assn. Showing the desirability and almost the necessity of securing other uses for gas than lighting, and the means of advancing this industry. Discussion. 5800 w. Pro Age—June 1, 1898. No. 20622.

SEWERAGE.**Damages.**

Damages Due to Sewage Disposal. Reviews a recent decision by the State Supreme Court of New York. 1500 w. Eng Rec—June 4, 1898. No. 20641.

Filtration.

Sewage Filtration at Winsford. Describes a system of filtration which has been in use for nearly twenty years with marked success, and the conditions which have made the cost of operation small. 3300 w. Engr, Lond—June 17, 1898. No. 21186 A.

Oyster Beds.

Oysters and Sewage. Describes conditions causing enteric fever in Brightlingsea, England. 600 w. Eng Rec—May 28, 1898. No. 20535.

Pollution.

An Injunction Against Sewage Pollution of a California Stream. Review of an important decision of the Supreme Court. 900 w. Eng Rec—June 25, 1898. No. 21158.

Sewage.

The Sewerage of Paris, France. James H. Fuertes. Illustrated explanation of features previously undescribed. 1200 w. Eng Rec—June 11, 1898. Serial. 1st part. No. 20805.

Sewage Disposal.

Report on the Precipitation System of Sewage Disposal in Operation at Hamilton, Ont. W. M. Watson. Details and account of expenses, showing that the system is very costly. 2500 w. Can Engr—June, 1898. No. 20786.

Sewage Disposal. Benjamin F. La Rue. From *Home Study Magazine*. Introductory remarks with brief notice of the methods of natural disposal, clarification and application to the soil. 2500 w. Sci Am Sup—June 11, 1898. No. 20746.

The Dilution Process of Sewage Disposal. Rudolph Hering. An examination of the conditions under which sewage may be made harmless as a waste discharge by dilution in public water courses and other bodies of water. 3500 w. Engineering Magazine—July, 1898. No. 21233 B.

STREETS AND PAVEMENTS.**Asphalt.**

Laboratory Tests of Asphalt. A. W. Dow.

Gives a copy of the report of S. P. Sadtler to the city clerk of Los Angeles, Cal., with criticisms of the conclusions drawn from the results obtained. 2800 w. Munic Engng—June, 1898. No. 20550 C.

Brick Testing.

Standard Methods of Testing Paving Brick. Arthur N. Talbot. Describes a series of tests made in the Laboratory of Applied Mechanics, Univ. of Illinois, which show that the standard method of the Nat. Brick Mfrs. Assn. should not be adopted without further investigation. 2000 w. Technograph, No. 12—1897-8. No. 20908 D.

Testing Paving Brick. Describes recent tests indicating defects in National Brick Manufacturers' Assn. specifications. 900 w. Eng Rec—June 18, 1898. No. 20932.

Pavements.

A Decision as to Front-Foot Assessments. A review of a decision by the Wisconsin Supreme Court as to the legal forms which must be followed to make such assessments binding. 900 w. Eng Rec—May 28, 1898. No. 20533.

Cement Grout for Pavements. Report of tests at Albany to determine best way of making grout. 800 w. Eng Rec—May 28, 1898. No. 20542.

Stone Block Street Pavements. Charles Carroll Brown. The importance of a good foundation, and care in selecting blocks of uniform size. While the first cost is high, the pavement is almost indestructible. 800 w. Stone—June, 1898. No. 21216 C.

WATER SUPPLY.

Analyses.

Interpretation of Water Analyses. Floyd Davis. Abstract of a paper read before the Iowa Engineering Soc. Reviews the methods used in investigating water supply, giving much information of evidences of contamination. 4800 w. Munic Engng—June, 1898. No. 20551 C.

Birmingham.

The Water Supply of Birmingham. (L'Alimentation d'Eau de Birmingham.) A description from English sources, with photographic illustration of pumping engines. 1800 w. La Revue Technique—May 25, 1898. No. 21016 D.

Cardiff.

Extension of Filter-Beds, &c., Service Reservoirs, and Water Tower, Cardiff. C. H. Priestley. Abstract of paper and discussion at meeting of British Assn. of Water-Works Engs. Description of improvements. 4800 w. Jour Gas Lgt—June 7, 1898. No. 20885 A.

Contracts.

Municipal Franchise Contracts. H. E. Keeler. Read before the Am. Water Works Assn. Discusses the proper relations of municipalities and private water companies. 2800 w. Eng Rec—June 25, 1898. No. 21161.

Compressed Air.

Compressed Air for Water Works. Oscar Darling. Illustrated description of the application of compressed air to the operation of

water-supply systems, with a statement of the advantages claimed. 800 w. Fire & Water—June 11, 1898. No. 20809.

Croton Dam.

The New Croton Dam. Illustrated description of the design and construction to date of this remarkable structure. 5300 w. Eng Rec—June 11, 1898. No. 20803.

Discharge.

Description of the Method of Gauging the Discharge Through the Outlet of Hemlock Lake, N. Y. John F. Skinner. Describes the method used to ascertain the discharge of Hemlock Lake, the source of the water supply of Rochester, N. Y., through its outlet. 1800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21133 D.

Fermentation.

Ridgewood Reservoir Diatoms. Samuel McElroy. A statement of the conditions and an explanation of the cause of the trouble. 1300 w. Fire & Water—June 11, 1898. No. 20808.

Filtration.

Filtration at Reading. Gives an account of the sources of the supply, and the steps being taken to provide a filtration plant. 1400 w. Fire & Water—May 28, 1898. No. 20556.

My Experience in Filtration and Aeration. S. A. Charles. The writer's experience at Lexington, Ky., greatly favors the use of mechanical filters, with aeration. 1800 w. Fire & Water—June 18, 1898. No. 20943.

The Benefit of Water Filtration—Illustrative Examples. John W. Hill. Abstract of address before the Arapahoe and Denver Medical Society. Explains the method which nearly fifty years of use in Europe has proved to be practical and efficient. 1500 w. San—June, 1898. No. 20672 D.

The Efficiency of the London Filters. Summary of official data indicating a bacterial purification of over 99 per cent. in every case. 800 w. Eng Rec—May 28, 1898. No. 20540.

The Little Falls Sand Filter. Illustrated description of a one-acre open sand filter costing but \$11,750. 1200 w. Eng Rec—June 4, 1898. No. 20646.

The Operation of a Slow Sand Filter. Charles E. Fowler. Experiences and facts in regard to the first sand filter in America, located at Poughkeepsie, N. Y., to render the water of the Hudson fit for domestic use. Discussion. 15000 w. Jour of New Eng Water Works Assn—June, 1898. No. 20904 F.

The Water-Works and Filter Plant of Ripley, N. Y. E. A. Wilder. Describes the locality and conditions which were unusual, but successfully overcome by the use of a shield. Also describes the filter which had a capacity of 200,000 gallons per day. Ill. 2800 w. Eng News—June 9, 1898. No. 20771.

Flow.

Flow of Water. W. J. Millar. Discusses the three principal causes of loss of head. 700 w. Ind Engng—May 7, 1898. No. 20777 D.

Gas Engines.

Gas and Gasoline Engines as Applied to Small

Water-Works Plants. Charles O. Rogers. Paper read at meeting of Eng's Soc. of W. Penna., Pittsburg. Gives an account of various pumping plants where gas engines were installed, with tests made. 3000 w. Am Mfr & Ir Wld—May 27, 1898. No. 20554.

Inspection.

Cast-Iron Pipe Inspection. T. W. Yardley. Abstract of paper presented at meeting of Am. Water-Works Assn. Gives methods and requirements of inspection. 900 w. Eng Rec—June 18, 1898. No. 20937.

Leakage.

Loss of Water from Pipes. F. H. Crandall. A report on the Burlington (Vt.) High Service, which is free from many of the difficulties ordinarily encountered in solving this question. Discussion. 3000 w. Jour of New Eng Water Works Assn—June, 1898. No. 20905 F.

Manchester, Eng.

The Water Supply of Manchester, England. James H. Fuertes. Brief description of old and new works. 700 w. Eng Rec—June 4, 1898. No. 20648.

Mill Rights.

Compensation Water for Mills. Stephen E. Babcock. Paper, slightly condensed, read before the Am. Water-Works Assn. Describes the method adopted at Little Falls, N. Y., to avoid damages for injured water rights. 3000 w. Eng Rec—June 25, 1898. No. 21162.

Munich, Germany.

The Water-Works of Munich, Germany. James H. Fuertes. Illustrates a plant for intercepting about 50,000,000 gallons of ground water daily. 900 w. Eng Rec—June 25, 1898. No. 21163.

Olean Well.

The Story of a Well. A review of the legal difficulties caused by faulty specifications for a well. 1200 w. Eng Rec—June 11, 1898. No. 20802.

Pipe Test.

Test of Concrete Iron Pipe. Ernest L. Ransome. Describes test by hydraulic pressure of a pipe 7 feet in diameter. 600 w. Eng Rec—May 28, 1898. No. 20546.

Private Baths.

Free Water for Private Baths. L. N. Case. Extract from a paper presented at the recent convention of the Am. Water-Works Assn., condemning the project. 1000 w. Eng Rec—June 18, 1898. No. 20936.

Private Plant.

Water Supply and Sewerage of the Kunhardt Estate. Illustrated description of a complicated system for a large country place. 1500 w. Eng Rec—June 18, 1898. No. 20935.

Pumping Plant.

The Efficiency of Air Lift Apparatus. Herbert T. Abrams. A letter claiming 45 per cent. for a well designed plant. 700 w. Eng Rec—May 28, 1898. No. 20547.

Reservoirs.

An Artificial Ground Water Reservoir. De-

scribes a sunken masonry dam storing 5,700,000 cu. ft. in a gravel bed. 700 w. Eng Rec—May 28, 1898. No. 20541.

Covering a Storage Reservoir at Quincy, Ill. Dow R. Gwinn. Describes the construction of roof of white pine, built to lessen the trouble from vegetable growths. Ill. 1500 w. Eng News—June 9, 1898. No. 20776.

The Quincy, Ill., Settling Reservoir. Dow R. Gwinn. Illustrated description of a covered masonry basin with electric water-level annunciator. 1000 w. Eng Rec—June 4, 1898. No. 20647.

The Water Supply of St. Etienne, France. James H. Fuertes. Describes two remarkable reservoirs. 800 w. Eng Rec—May 28, 1898. No. 20539.

Rochester, N. Y.

A Few Considerations of Municipal Water Supply, with Special Reference to That of Rochester, N. Y. E. Kuichling. Briefly notices a few of the problems of water supply engineering, discusses the quality and quantity of the Rochester supply, and gives the general design and construction of the works. Ill. 4400 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21121 D.

St. Joseph, Mo.

St. Joseph's Valuable Water Plant. An account of the plant and the expensive additions made. New pumps, new filtering plant, many miles of new mains, etc. 1200 w. Fire & Water—May 28, 1898. No. 20555.

Steel Pipe.

A Rivetless Longitudinal Joint for Steel Pipe. Adelaide Water Works, South Australia. Alex. B. Moncrieff. Describes a new design of pipe considered in every respect an advance. 400 w. Eng News—June 9, 1898. No. 20775.

Submerged Mains.

Laying a 24-inch Main Under the Nashua River. Horace G. Holden. Describes the work of connecting the water mains by a loop that would supply the portion of the city of Nashua on the opposite side of the river, in case any accident occurred to the bridge that has for forty-four years held the suspended pipes. Discussion. 3000 w. Jour of New Eng Water Works Assn. June, 1898. No. 20906 F.

Town Supplies.

The Sources of Town Water Supplies, and Their Bearing Upon the Public Health. R. E. W. Berrington. Abstract of paper and discussion before the British Assn. of Water Works Eng's. Briefly notes the usual sources of supply, the need of being watchful of their purity, and of furnishing a plentiful supply. 3000 w. Jour Gas Lgt—June 14, 1898. No. 21106 A.

Water Project.

The Revival of the Ramapo Water Project. A review of various attempts to obtain private contracts to supply New York. 1200 w. Eng Rec—June 25, 1898. No. 21159.

Water Ram.

Unsteady Flow of Water in Pipes—Water Ram. Irving P. Church. A brief re-statement of the theory presented in a former article,

with an account of the work of B. F. Latting in this field, and later theoretical developments by the writer. Ill. 3800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21123 D.

Water Tank.

The Elevated Water Tank of the Iowa State Agricultural College. A. Marston. A design of the writer, including some novel features. Ill. 1800 w. Eng News—June 9, 1898. No. 20774.

Water Works.

Bay City Water Works. E. L. Dunbar. An interesting account of the construction of the works and the improvements made. 1700 w. Fire & Water—June 18, 1898. No. 20942.

Wyoming, Ohio.

Free Water and Meterage in Wyoming, Ohio. Discusses the present system and its defects, the objections to the meterage of water, and the finances. 800 w. Fire & Water—June 4, 1898. No. 20696.

MISCELLANY.

Address.

Presidential Address at the Third Annual Meeting of the Municipal Electrical Association, London. A. H. Gibbings. Deals principally with matters of interest to the association. 3800 w. Elec Eng, Lond—June 10, 1898. No. 20973 A.

Living Conditions.

The City's Health-Living Conditions. Dr. A. S. Daniel. An interesting paper on the life and work of the very poor, mostly foreigners, in New York City. 5500 w. Munic Af—June, 1898. No. 20920 C.

Management.

Management of Electrical Undertakings by Local Authorities. Councillor Hesford. Read at meeting of the Munic. Elec. Assn., London,

with discussion. 2500 w. Elec Eng, Lond—June 10, 1898. No. 20974 A.

Ownership.

Municipal Ownership. Roderick J. Parke. Presents the principal considerations for and against, and the control of municipal industrial services, especially the supplying of electrical current for street lighting, &c. Aims to present facts which must be considered before a wise conclusion can be reached. 2500 w. Can Eng—June, 1898. Serial. 1st part. No. 20783.

Refuse.

The Disposal of Household Refuse in New York. (L'Enlèvement et le Traitement des Ordures Ménagères à New York.) An illustrated description of the methods for handling garbage and light refuse, compiled from American sources. 2000 w. La Revue Technique—June 10, 1898. No. 21020 D.

Sanitation.

The City's Health-Sanitary Construction. Charles F. Wingate. Describing the changes which have taken place in New York city in recent years, showing the progress and the needed reforms. 4000 w. Munic Af—June, 1898. No. 20921 C.

Wastes.

The Present European Practice in the Disposal of the Wastes of Large Cities. James H. Fuertes. Deals with the receptacles, collection and disposal of refuse as carried out in various places. Ill. 5000 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21122 D.

Working Conditions.

The City's Health-Working Conditions. Henry White. A discussion of how the government of the city may improve the working conditions. Considers sweating, factory inspection, rents, &c. 4400 w. Munic Af—June, 1898. No. 20919 C.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in May. Detailed list with classified summary. 3500 w. R R Gaz—June 24, 1898. No. 21173.

Car Loading.

A Machine for Loading Box Cars. Gives a description and drawing of an ingenious machine for loading crushed phosphate rock into box cars. 600 w. Eng News—June 16, 1898. No. 20877.

India.

Some Features of Indian Railways. J. W. Parry. Showing many interesting features of railway operation and construction in India, and the conditions which have led to commercial success. 4000 w. Engineering Magazine—July 1898. No. 21232 B.

Organization.

Organization of a Railway Engineering De-

partment. Willard Beahan. The writer's views on a better organization of the engineering department of railroads with a view to saving money for the owners of the stock and bonds of the roads. 5300 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21124 D.

The Organization of a Railway. J. H. Good-year. Discussing the operating department of American railways, and how it may be improved. 2000 w. Ry Age—June 17, 1898. No. 20927.

Punctuality.

Punctuality of the Black Diamond Express. Report of this train for the 12 months ending Dec. 31, 1897. 400 w. R R Gaz—June 17, 1898. No. 20891.

Railway Unpunctuality. Editorial discussion of some of the important points in connection with the habitual lack of punctuality on the British railways. 4000 w. Engng—May 20, 1898. No. 20582 A.

Repairs.

Is It Desirable to Instruct Trainmen in the

Details of Car Construction and Repairs? J. H. Goodyear. Thinks an improvement in service would certainly follow the instruction of trainmen to some extent in these details. 1300 w. *Ry Mas Mech*—June, 1898. No. 20733.

Signals.

The Signal System at Glandorf Station. (Die Sicherungsanlage der Station Glandorf.) A full description of this electric block signal system on the Austrian State Railways, with scheme diagrams showing the connection system. 3000 w. *Zeitschr d Oesterr Ing u Arch Ver*—June 3, 1898. No. 21055 B.

Train Services.

The May Train Services. Charles Rous-Marten. A criticism of the summer service timetables in England. 1300 w. *Engr, Lond*—May 20, 1898. No. 20576 A.

FINANCIAL.

Earnings.

Railway Earnings Continue Large. Record for May, 1898, and for the first five months of the year of the roads of the United States. 2000 w. *Bradstreet's*. June 11, 1898. No. 20781.

France.

The Railways of France. (Chemins de Fer Français.) A review of the financial workings of the French railways during 1897, with comments on the rates and character of the business. 2000 w. *Moniteur Industriel*—May 21, 1898. No. 21060 G.

LEGAL MATTERS.

Interstate Commerce.

The Sphere of the Interstate Commerce Commission. Discussing whether the Commission fulfills the ends for which it was created, and if not, what is needed to make it do so. 3500 w. *Ry Age*—June 3, 1898. No. 20730.

MOTIVE POWER AND EQUIPMENT.

Air Brake.

The Chapsal Brake and Improvements in Railway Brakes. (Le Frein Chapsal, et les Perfectionnements des Freins de Chemins de Fer.) A discussion of the relative merits of the Chapsal and the Westinghouse brakes, maintaining the superiority of the electro-pneumatic system of Chapsal. 5000 w. *La Revue Technique*—May 10, 1898. No. 21011 D.

The "Standard" Air Brake for Street Cars. A description of the several parts, with illustrations, considering the driving mechanism, the pump, the governor, the operating valve, and the platform equipment. 1400 w. *RR Gaz*—June 3, 1898. No. 20636.

Box Cars.

Standard 60,000 Pounds Capacity Box Cars—Lake Shore and Michigan Southern Railway. Engravings showing construction, with description. 1500 w. *RR Gaz*—June 10, 1898. No. 20792.

Car Springs.

Development of the Car Spring. Angus Sinclair, in *The Pall Mall Magazine*. A short account of the first real improvement made in

springs, and the added comfort secured. 600 w. *Loc Engng*—June, 1898. No. 20691 C.

Car Ventilator.

Passenger Car Ventilation. Granville P. Conn. Considers what constitutes a vitiated atmosphere, and the points especially to be studied in car ventilation. 2000 w. *RR Car Jour*—June, 1898. No. 20788.

Cleaning.

Car Cleaning. F. T. Slack. A statement of methods employed and materials used. Discussion. 9500 w. *N. Y. R.R. Club*—May 19, 1898. No. 21151 D.

Coal Cars.

80,000-Lb. Coal Cars. Illinois Central R. R. Illustrated description giving dimensions. 1000 w. *Eng News*—June 16, 1898. No. 20873.

New 60,000-Pound Coal Cars—Lake Shore and Michigan Southern Railway. Illustrates a design for special service in the coal and ore trade from Lake Erie ports and for use with the McMyler unloading machine. 900 w. *Am Eng & RR Jour*—June, 1898. No. 20603 C.

Couplers.

The Breaking in Two of Freight Trains. Mentions the causes of the parting of trains, and offers suggestions tending to reduce the dangers, if they do not entirely prevent. 1300 w. *Am Eng & RR Jour*—June, 1898. No. 20608 C.

Crank Pins.

A Comparison of Fiber Stresses in Crank Pins and Axles. L. R. Pomeroy. Gives a table showing the material, dimensions and fiber-stress on pins and axles taken from modern engines, with comments. 700 w. *RR Gaz*—June 17, 1898. No. 20889.

Draft Gear.

The Westinghouse Friction Draft Gear. Describes the buffer as now made, and notes other improvements, describing the action of the apparatus in buffing and its release, and its performance as a draft gear, reporting experiments of a satisfactory nature. Ill. 2000 w. *RR Gaz*—June 10, 1898. No. 20796.

Driving Wheels.

Cast Steel Driving Wheel Centers. Illustrations and descriptions of changes in design, reproduced from working drawings of wheels in regular service. 900 w. *Ry & Engng Rev*—June 18, 1898. No. 20928.

Headlights.

Electric Headlights for Locomotives. States the advantages of electric headlights, and gives report of a test made on the C. C. C. & St. L. Ry. and describes an apparatus designed by George C. Pyle. Ill. 1400 w. *Eng News*—June 16, 1898. No. 20876.

Locomotive Design.

General Principles Governing Locomotive Design. H. Wade Hibbard. Considers the general principles concerned in operation and repair, with less important and exterior influences. 4000 w. *Sib Jour of Engng*—June, 1898. No. 20676 C.

Locomotive Design—The Working Stress of

Materials. Francis J. Cole. A study of driving axles, considering their size and the stresses. 2800 w. Am Eng & R R Jour—June, 1898. No. 20609 c.

Locomotive Statistics.

The Ton Mile and Engine Mile in Locomotive Statistics. W. H. Marshall. Showing that changed conditions have destroyed the value of engine-mile records, and made them misleading when employed as a basis for calculating the cost of engine service, and discussing items entering into locomotive expenses. 3000 w. Am Eng & R R Jour—June, 1898. No. 20611 c.

Locomotives.

Baldwin Two Cylinder Compound Locomotives—Norfolk and Western Railway. Describes heavy two cylinder compound consolidation locomotives, having interesting features. Drawings. 1500 w. Am Eng & R R Jour—June, 1898. No. 20602 c.

Competitive Tests of Locomotives. M. N. F. Discusses the methods of testing, or the conditions under which tests are made, and claims that a test which is not competitive proves very little. Suggests that competitive tests be made under the direction of a committee of the Master Mechanics Assn., the object being to ascertain what kind of a locomotive is best adapted for a certain kind of traffic. 3300 w. Am Eng & R R Jour—June, 1898. No. 20607 c.

Compound Express Locomotive for the Northern Railway of France. Illustrates and describes this latest type of the compound express locomotives of this company, which are characterized by exceptional boiler capacity. 1300 w. Engng—June 3, 1898. Serial. 1st part. No. 20834 A.

Locomotive Characteristics. G. R. Henderson. The object of the article is to determine the conditions under which the maximum amount of work or power can be obtained from any given locomotive, of known proportions, regardless of the fuel economy. 1500 w. Am Eng & R R Jour—June, 1898. No. 20606 c.

Locomotive Tenders and Truck Wheels. Editorial discussion of the difference between American and British practice, with the opinions of motive-power men and locomotive builders. 3000 w. Eng News—June 9, 1898. No. 20773.

Passenger Engines—Retrospect and Prospect. George W. Cushing. Reviews the Chicago and Northwestern system, taking it as an example of western roads. Ill. 1800 w. Ry Mas Mech—June, 1898. No. 20732.

Principal Types of Locomotives in Use in Europe and America. (Principaux Types de Locomotives Actuellement en Usage en Europe et en Amerique.) A list with brief general description of 63 different types of locomotives. 5000 w. 1 plate. Le Génie Civil—May 28, June 4, 1898. Two articles. No. 21006 each D.

Reconstructing Locomotives. Francis R. F. Brown. Notes on the results obtained, showing that the advantages and cost recommend

it to careful consideration. 900 w. Am Eng & R R Jour—June, 1898. No. 20612 c.

Simple Ten-Wheel Locomotives with Piston Valves—Wisconsin Central Lines. Illustrates and describes passenger and freight locomotives specially interesting because of the application of piston valves. 1000 w. Am Eng & R R Jour—June, 1898. No. 20604 c.

Spring and Equalizer Action in Locomotives. A. Von Borries. Extracts from an important work, selected and translated by W. W. Nichols. Deals with the influence of equalizers and springs upon the safety of the progress of a locomotive. 1800 w. R R Gaz—June 10, 1898. No. 20797.

Ten-Wheel Passenger Locomotive; Southern Ry. Describes some of the heaviest locomotives built for passenger service, giving some information relating to speed, a comparison of other heavy engines of the same type, and general dimensions. Ill. 500 w. Eng News—June 16, 1898. No. 20878.

The Efficiency of High Steam Pressures for Locomotives. Condensed from the report of a Committee of the American Railway Master Mechanics' Assn. Presented at the Saratoga meeting. 4800 w. Eng News—June 23, 1898. No. 21115.

Wabash Ten-Wheel Freight Engine. Illustrated description of some of the details, with principal dimensions. 600 w. Ry & Engng Rev—May 28, 1898. No. 20563.

Winans' Camel Engines. M. N. Forney. Illustrated description of some old locomotives long used on the Baltimore and Ohio R. R. noting their interesting features. 4500 w. Am Eng & R R Jour—June, 1898. No. 20610 c.

Locomotive Tests.

Locomotive Road Tests—Illinois Central Railroad. Reports investigations made by the students of the Mech. Engng. Dept. of the Univ. of Illinois of the operations of the locomotives of that road. Ill. 2400 w. R R Gaz—June 17, 1898. No. 20893.

Platforms.

Steel Platforms for Passenger Cars. Compares wood and steel platform construction, noting the superiority of the latter in preventing telescoping of cars, and other damages. 800 w. R R Gaz—June 10, 1898. No. 20794.

Pneumatic Press.

Pneumatic Press with Oil Resistance Cylinder—New York, Ontario and Western Railway. Engravings with description of the principal features of a portable pneumatic press used in the shops of the N. Y., O., and W. Ry. 600 w. R R Gaz—June 17, 1898. No. 20888.

Repairs.

Western Prices for Labor vs. Eastern. An important discussion at the Master Car Builders' convention, 5800 w. Ry Age—June 24, 1898. No. 21217.

Reports.

Master Car Builders' Reports. Committee reports presented at the Saratoga meeting—Thermal tests for car wheels, steel car framing, care of journal boxes, springs for freight car

trucks, &c. 5500 w. R R Gaz—June 17, 1898. No. 20892.

Master Mechanics Reports. Gives reports presented at the Saratoga meeting of the association. 13500 w. R R Gaz—June 24, 1898. No. 21172.

Steel Cars.

100,000-Lbs Steel Car. N. Y. C., & H. R. R. R. Illustrated description. 700 w. Ry & Eng Rev—June 11, 1898. No. 20851.

Tenders.

American Tenders for the Imperial Government Railways of Japan. Illustrates and describes a novel style of six-wheel tender to be used with eight-wheel passenger locomotives. 700 w. Eng News—June 9, 1898. No. 20770.

Train.

The Pioneer Limited. Illustrated description of fine cars placed in service on the C. M. & St. P. R. R. 2200 w. Ry & Eng Rev—June 11, 1898. No. 20849.

Wheels.

Balancing of Car Wheels. J. E. Simons. Is of the opinion that cast-iron wheels should be balanced before being placed in service. 1000 w. R R Car Jour—June, 1898. No. 20790.

Car Wheels—Mileage and Thermal Tests. T. A. Griffin. A general average computation of the life of freight car wheels, and a statement of the conditions that have affected the results, with conclusions on thermal tests. 6000 w. Ry Age—June 10, 1898. No. 20799.

Chilled Cast Iron Wheels. E. W. Grieves. A discussion of defects in wheels, and the question of replacing wheels which have failed. Ill. 1200 w. R R Car Jour—June, 1898. No. 20791.

Thermal Tests for Car Wheels. S. P. Bush. Abstract of a paper presented at the Saratoga, N. Y., convention of the Master Car Builders' Assn. A presentation of facts relating to these tests, showing that there is no reason to believe that in obtaining greater safety, durability is sacrificed. 1500 w. Eng News—June 23, 1898. No. 21114.

NEW PROJECTS.

Brussels.

The Metropolitan Railway of Brussels. (Le Métropolitain de Bruxelles.) A discussion of the proposed tunnel and depressed local railway now under consideration for the city of Brussels. 2000 w. Moniteur Industriel—June 11, 1898. No. 21062 G.

Burma.

The Development of Railways in Burma. An account of the methods of working, which, owing to the inferior qualities of labor, are altogether different from the usual practice. The construction and progress are also considered. 2800 w. Engng—June 3, 1898. No. 20829 A.

China.

Notes on the Proposed Siberian-Chinese Railway to China and Korea. (Mittheilungen über der Geplanten Ausban der Sibirisch-Ost-

chinesischen Eisenbahn nach Korea und China.) With map showing the projected lines, the portion now under construction, and the connections with various steamship lines. 1000 w. Glaser's Annalen—May 15, 1898. No. 21063 D.

Railway Enterprises in China. Translations from Chinese journals in reference to railroad construction. 1300 w. Cons Repts, No. 148—June 23, 1898. No. 21150 D.

Railway Projects on the South-Western Frontier of China. Reports concerning concessions secured by Sir Claude Macdonald, the situation in relation to the French, and the projects completed, in course of construction, and proposed. Map. 3000 w. Engr, Lond—May 20, 1898. No. 20575 A.

Improvements.

The Doubling of the North-Western Railway of India, between Karachi and Kotri. Explains reasons for this change by the increase of traffic, and also the construction of a line including a bridge, advocated by reason of the liability of the road to inundation. 5800 w. Ind & East Engr—May, 1898. Serial. 1st part. No. 20846 D.

Jungfrau.

The Jungfrau Railway. (Die Jungfraubahn.) A general description of the mountain road now in course of construction with views of the present state of the work at various points. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—May 27, 1898. No. 21052 B.

Light Railways.

Light Railways. Editorial on the schemes promoted in Great Britain since the Light Railways Act came in force, giving some of the conditions stipulated, and tabulated lists of railways, approved, and applied for. 2500 w. Engng—June 17, 1898. No. 21182 A.

Narrow Gauge.

Light Railways. Describes the Barsi Light Railway and the Darjeeling-Himalayan Railway. 4000 w. Ind Engng—May 21, 1898. Serial. 1st part. No. 21168 D.

Siberian Railroad.

The Trans-Siberian Railroad. Details from the report of the Imperial Commission to the Tsar on the progress made during the five years ending with 1897. 4800 w. Engr, Lond—June 3, 1898. No. 20823 A.

South America.

South American Railways. Details with respect to Argentina railways, with brief notice of other lines. 1700 w. Engng—May 27, 1898. No. 20710 A.

PERMANENT WAY, BUILDING AND FIXTURES.

Crossings.

A Short Method for Railroad Crossing Computations. L. K. Vial, and R. B. Ketchum. Gives in detail a solution used by the Ajax Forge Co., Chicago, and by the Western Indiana Railway Co., with a discussion of the approximation involved, and a brief comparison

with other methods. 1500 w. *Technograph*, No. 12—1897-8. No. 20917 D.

Mono-Rail.

The Portable Mono-Rail Transport System. C. C. Hoyer Millar. Read before the Inst. of Min. & Met., London. Gives a general description of the system and considers its advantages. 1100 w. *Col Guard*—June 10, 1898. No. 20964 A.

Philippines.

Railroading in the Philippines. J. T. M. A description of the railway from Manila before Admiral Dewey arrived. 2000 w. *Ry Age*—May 27, 1898. No. 20557.

Pole Railway.

A Pole Railway. Details of a novel road in Nova Scotia for conveying lumber. Ill. 500 w. *Can Engr*—June, 1898. No. 20784.

Rack Railway.

The Development of the Abt Rack Railway System in Austro-Hungary during the past 10 years. (Die Entwicklung des Zahnrad systemes Abt während der Letzten 10 Jahre in Oesterreich-Ungarn.) Roman Abt. A general review of the progress of the Abt systems since 1888 with illustrations of many types of locomotives and details of construction and operation of roads. 6000 w. *Zeitschr d Oesterr Ing u Arch Ver*—May 13, 20, 1898. Two articles. No. 21050 each B.

Rails.

Laying New Steel. E. A. Haskell. Gives a description of the method of work in track laying on the Boston & Albany Railroad. 2800 w. *R R Gaz*—June 3, 1898. No. 20637.

Shops.

The Horwich Locomotive Works of the Lancashire & Yorkshire Railway, England. William Forsyth. General plan and brief description of the principal departments of these English shops, which are the largest locomotive repair shops in the world. 1500 w. *Am Eng & R R Jour*—June, 1898. No. 20605 C.

Rail.

An Old Edge Rail, from the Eastern Railway of Massachusetts and New Hampshire. Illustrates and describes an interesting relic of railway history. 700 w. *Eng News*—June 16, 1898. No. 20874.

Signals.

Electric Automatic Signals—The Right to Use the Overlap. Gives a synopsis of the decision in the suit of the Union Switch Signal Co. against the Philadelphia and Reading R. R. 2200 w. *R R Gaz*—June 17, 1898. No. 20887.

Electric Warning Signals for Unguarded Railway Crossings. (Elektrische Warnungslänterwerke für Unbewachte Bahnüberwege.) L. Kohlfürst. Describing and illustrating several systems for giving an audible warning signal at grade crossings when a train is approaching; avoiding the necessity for an attendant. 2500 w. *Elektrotech Zeitschr*—My 12, 1898. No. 21075 B.

Steel Rails.

Steel Permanent Way. Richard Price-Williams. Read before the Iron & Steel Inst., England. Shows that iron rails could not endure the enormous increase in traffic and tractive power on heavily worked lines, and discusses what has been accomplished in the way of improving and strengthening the permanent way reducing cost, &c., and what needs yet to be remedied. 3800 w. *Engng*—June 3, 1898. No. 20835 A.

Timber Structures.

Notes on Inspection of Timber Structures. Justin Burns. Suggestions to bridge inspectors in the maintenance department of railroads. 2500 w. *Trans of Assn of Civ Engs of Cornell Univ*—1898. No. 21125 D.

Tanks.

Self-Feeding Railroad Tanks. Julien A. Hall. Gives some important points in connection with gravity water supply, and shows the advantages of this system. 1400 w. *Ry & Eng Rev*—June 11, 1898. No. 20850.

Track Joints.

The Relation of Wave Motion in Track to Track Joints. George Tatnall. Discusses the requisites for a good track joint, shows the fallacy of the idea that the ties are fixed and solid supports, giving experiments confirming the facts, and other features of the designing of track joints. 3000 w. *R R Gaz*—June 17, 1898. No. 20894.

Track Layer.

Machine for Laying Railway Track. (Maschine zum Verlegen von Gleisen.) The Behrens apparatus is intended for handling sections of track and steel sleepers, and consists of a cantilever crane carried on a special steam motor car which hauls the construction train. 1800 w. 2 plates. *Zeitschr d Ver Deutscher Ing*—May 21, 1898. No. 21038 D.

TRAFFIC.

Agreement.

The Southwestern Bureau. The essential articles of the agreement entered by eleven roads, and a statement of its purpose. 1400 w. *Ry Age*—May 20, 1898. No. 20319.

Rates.

Causes Affecting Railway Rates and Fares. W. E. Weyl. A comparison showing the decline in passenger fares to have been much slower than in freight rates, with a study of the causes, and the peculiar conditions that have caused the discrepancy in the United States. 9000 w. *An Am Acad*—May, 1898. No. 20306 H.

The Lone Star Case. Gives a history of the trouble which caused a demoralization of rates between New York and Texas, with a statement of the case and opinion of the court. 1800 w. *R R Gaz*—June 17, 1898. No. 20890.

Traffic.

The Southwestern Passenger Agreement. An account of the organization of this bureau, with the essential parts of the agreement. 3000 w. *Ry Age*—June 3, 1898. No. 20731.

STREET AND ELECTRIC TRAMWAYS.

Baltimore, Md.

Electric Street Railways in Baltimore, Md. C. B. Fairchild. Notes on the interesting features of the two systems controlling most of the street-railway mileage, considering the power stations, repair shop practice, rolling stock, discipline, &c. 3000 w. Elec Eng, N. Y.—May 26, 1898. No. 2 529.

Car Design.

Electric Tramway Car Design. W. E. Partidge. Shows that each type must be adapted to its special work, and gives various designs illustrating the text. 2200 w. Ry Wld—June 2, 1898. No. 20987 A.

Electric Traction.

Electric Traction on Important Lines and the Locomotive. Extracts from paper by Maurice Demoulin. Considers the advantages and disadvantages as compared with steam. 2800 w. Ind & East Engr—May, 1898. No. 20844 D.

Electrolysis.

Electrolysis of Gas and Water Mains. Report of W. A. Chamen, Glasgow electrical engineer. Describes the system of banding, and gives his opinion that there will be no trouble with the electrolysis of gas and water mains as long as the limit is not exceeded. 1200 w. Jour Gas Lgt—June 7, 1898. No. 20886 A.

Gas Trams.

Gas Tramways. (Gasbahnen.) Hubert Nachtsheim. A very complete and fully illustrated description of the Lührig gas-motor tramway system as installed at Dessau, with discussion. 7500 w. 1 plate. Mitt d Ver f d Förd d Local-u Strassenbahnwesens—May, 1898. No. 21091 E.

London Motors.

Specifications for Motors Used on the Central Underground Railway of London. Letter from E. D. Priest of the Gen. Elec. Co. sent in response to a request for further details of these electric locomotives. 900 w. Eng News—June 16, 1898. No. 20875.

Locomotive.

Electric Locomotive for the London Central Underground Railway. Gives the revised plans of the locomotives to be used on this railway. Ill. 800 w. Eng News—June 9, 1898. No. 20772.

Los Angeles, Cal.

The System and Methods of the Los Angeles Railway Company. Brief remarks on the rapid growth of the city, and the development of the street railway system, with illustrated detailed description of the present well-equipped electric system. 3800 w. St Ry Jour—June, 1898. No. 20590 D.

Modern Plants.

Modern Electric Railway Plants. Brief illustrated descriptions of the plants of the Union Traction Company of Philadelphia, and of the South Side Elevated Railroad of Chicago. 2600 w. Engr, N. Y.—June 1, 1898. No. 20640.

Power Cost.

The Cost of Mechanical Traction on Tramways. (Sur le Prix d'Exploitation de Traction Mécanique Appliquée aux Tramways.) A general examination of the items of cost of operation of the fireless locomotive system, based upon data obtained from actual experience. 2000 w. La Revue Technique—May 10, 1898. No. 21014 D.

Project.

The Waunsee Railway Project. (Das Kübler-Schimpff'scher Waunseebahn-Projekt.) A description of the scheme of Kübler and Schimpff for an electric road from Berlin to the Wansee with details of the plant. 1800 w. Elecktrotech Zeitschr—June 2, 1898. No. 21084 B.

Rails.

Continuous Rails. Richard McCulloch. Illustrates and describes methods which have been used in the United States, with information concerning the kind of rails used. 3200 w. Ry Wld—June 2, 1898. No. 20986 A.

Rapid Transit.

Power Consumption in Rapid Transit Service. A. H. Armstrong. Describes in detail the plotting of curves showing the relation between speed-time and distance-time, curves showing maximum speeds reached, the relative amount of energy required for the different rates of acceleration, &c. 3000 w. St Ry Jour—June, 1898. No. 20591 D.

Society.

The International Permanent Street-Railway Society. (Internationaler Permanenter Strassenbahn-Verein.) An account of the general convention in Geneva, with a condensed abstract of the subjects and discussions. 3000 w. Glaser's Annalen—May 15, 1898. No. 21064 D.

Tramway.

Kidderminster and Stourport Electric Tramway. Full illustrated description of an English interurban line and its equipment. 3500 w. Ry Wld—June 2, 1898. No. 20985 A.

Kidderminster and Stourport Electric Tramway. Illustrated detailed description of a British line. 1400 w. Elect'n, Lond—May 20, 1898. No. 20571 A.

The British Electric Traction Company. Abstract of address of Emil Gareke, at the staff dinner of the company. Gives an outline of the work accomplished and in prospect, with many interesting matters relating to tramways. 3500 w. Ry Wld—June 2, 1898. No. 20989 A.

Underground Railways.

Metropolitan Railways. Editorial discussing the difficulties to be overcome in using electricity as the power in the London underground railway. 1400 w. Engr, Lond—May 27, 1898. No. 20707 A.

Underground.

Waterloo and City Railway. A description of this interesting English line, with illustrations of the equipment. Map. 2000 w. Ry Wld—June 2, 1898. No. 20988 A.

BOOKS OF MONTH



THE HEAT EFFICIENCY OF STEAM BOILERS: LAND, MARINE, AND LOCOMOTIVE. With tests and experiments on different types, heating values of fuels, analyses of gases, evaporation, and suggestions for testing boilers. By Bryan Donkin, M. Inst. C. E., &c. &c. London: Charles Griffin & Company, Limited. 1898.

The subject of testing steam machinery is now being discussed with more than usual energy, and hence the appearance of a work upon the subject of boilers trials from the pen of an expert like Mr. Bryan Donkin is especially timely. So many of the reported trials are contained in special reports, transactions of societies, and private records, that even a trustworthy collection of reliable tests would be welcome, but when to such a collection is added the results of Mr. Donkin's own experience, together with discussions on air supply, heat transmission, stoking, smoke prevention, etc., it will be seen how valuable the book must become to engineer and steam user alike.

As the author says: "Very large sums of money, representing many millions sterling, have been invested in steam boilers, and thousands of engineers are studying economy in coal. The question of heat efficiency is, therefore, not a small one. To generate steam a very large amount of fuel is consumed every year, and much is wasted. If ten or fifteen per cent. could be economized, a very moderate estimate, it would represent a great gain to the world at large. The total annual production of coal in all countries a few years ago was 400 millions of tons. We shall not be far wrong in estimating that one-half, or 200 million tons, is used yearly for generating steam. Putting the cost per ton at the low average of price of 10 shillings, we get 100 million pounds sterling as about the annual value of the fuel consumed under stationary, semi-portable locomotive and marine boilers."

It is to assist in the use of methods of testing, the object of which is the saving

of as much as possible of the fuel wasted, that the book before us is intended to serve, and it is admirably adapted to accomplish this end.

After a brief introductory descriptive chapter, the main portion of the work appears in the collection of tables of tests, giving in clearly tabulated form the results of 425 experiments on English and foreign boilers, with details of the boilers, computations of the efficiencies, temperature and analyses of gases, thermal values of fuels and the full results of the tests, with the authorities, localities, dates, and all necessary explanatory remarks. In nearly every test, therefore, the experimenter can turn to this collection, with the reasonable assurance that he will find something closely corresponding to the work he may have in hand and thus be provided with most useful comparative data.

Among the interesting chapters which follow the tables we may especially note that on the transmission of heat through boiler plates, as it contains a valuable compilation of the tests of Blechynden, Durs-ton, Hirsch, Witz, and Kirk, on the much discussed subject.

The general conclusion which is drawn from all these investigations is that "to obtain a maximum efficiency of transmission the cross section of the gas passages should be made small, and thus as high a speed obtained as practicable. The fire-box surfaces should be kept within such limits that the transmission per square foot is the same as that of the gases entering the tubes, and a good circulation of water is essential."

Other important chapters are those on smoke prevention, superheaters, and instruments, while the concluding list of various types of boilers is both interesting and useful.

The book is very fully illustrated and handsomely printed.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

Harrison Safety Boiler Works, Philadelphia, Pa., U. S. A.=Illustrated catalogue of Cochran separators, or appliances for removing liquids or solids from steam or other vaporous or gaseous currents. The construction and action of the apparatus are very fully shown.

The King Bridge Co., Cleveland, Ohio, U. S. A.=Catalogue of iron and steel bridges, viaducts, turntables, girders, buildings, eye bars, and structural work of all kinds; with many illustrations of completed structures built by the company.

The Phosphor-Bronze Smelting Company, Limited, Philadelphia, Pa., U. S. A.=Revised price list No. 13, with tables of gauges, sizes, weights and prices of various phosphor-bronze products, together with discount sheet. Also circular of Delta Metal.

The John M. Rogers Boat, Gauge, and Drill Works, Gloucester City, New Jersey, U. S. A.=Catalogue of measuring instruments of precision after Richard's system; also adjustable blade shell reamers, rose chucking reamers, rock drills, and special tools and machinery.

J. H. Williams & Co., Brooklyn, New York.=Illustrated catalogues (a) of miscellaneous drop forgings in iron, steel, copper, bronze, and aluminum; (b) of bicycle drop forgings, including lists of all drop forged parts; (c) of drop forged golf club heads of mild steel; (d) description of bathing system in the company's works; (e) description of the fire department of the establishment, and the system of fire protection.

Boston Belting Company, Boston, Mass., U. S. A.=Pamphlet showing the trade marks used on the various products of the company, by means of which they may be identified.

The Ball Bearing Co., Boston, Mass., U. S. A.=Catalogues of "Hub" ball and roller bearings, illustrating various forms of thrust bearings, steps, hub roller bearings, and anti-friction axles, together with prices, code words, testimonials, and a list of users.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Graphite as a lubricant; giving data and results of scientific tests, also opinions of mechanical experts as to the value of graphite, both as a lubricant and as an accessory for engineers and machinists.

The International Correspondence Schools, Scranton, Pa., U. S. A.= "What Correspondence Instruction Is." A pamphlet describing the methods of instruction used by the correspondence school, with especial reference to the nature and value of the special instruction books provided.

The Bucyrus Company, South Milwaukee, Wis., U. S. A.=Illustrated catalogues, Part 2, Small Dipper Dredges, of capacity from $\frac{1}{2}$ to $1\frac{1}{2}$ yard; Part 3, Large Dipper Dredges, from 2 to 10

yard capacity; Part 4, Elevator Dredges. Very completely illustrated, and showing the capacity of the concern both for large and small work.

The Risdon Iron Works, San Francisco, Cal., U. S. A.=Catalogue No. 15, Gold Dredging Machinery; Catalogue No. 16, Gold Dredging on Feather River, California; with numerous illustrations, showing dredges in operation.

John Tullis & Son, Bridgeton, Glasgow, Scotland.=Illustrated price list a catalogue of leather, cotton and gutta percha belting, with full description of the various designs and of other supplies such as hydraulic rings, belting fasteners, fire brigade hose; also telegraphic code and useful information on belt driving.

Richmond & Chandler, Ltd., Southall St., Manchester, England.=Illustrated catalogue of agricultural implements and machines, including a new steel drill which has an arrangement for instantly stopping the seed when turning the headlands, a full line of implements are described.

The United Flexible Metallic Tubing Co., Ltd., 112 Queen Victoria St., London, E. C.=Illustrated price list of hardened bronze and steel wired flexible tubing, with list of users.

Sam. Denison & Son, Hunslet Foundry, Leeds, England.=Illustrated price list and catalogue of weighing machines and weighbridges; upwards of fifty types are described, including suspended weighers of 100 tons capacity.

The Thames Mining Machinery Co., Ltd., 83 Cannon St., London, E. C.=Illustrated catalogue of the Jelman-Wepp mining machinery, crushers, cyanide plants, compressors, rock drills, stamps, batteries, etc.

Bruce & Still, Ltd., Norfolk St., Liverpool, England.=Illustrated price list of galvanized corrugated iron buildings and churches.

The Britannia Co., Colchester, England.=Large illustrated catalogue of a great variety of machine tools and engineers' hand tools; also of wood working machinery, twist drills, etc.

Chas. Burrell & Sons, Ltd., St. Nicholas Works, Thetford, England.= (a) Illustrated catalogue of patent road locomotives, traction engines, road rollers, ploughs and other agricultural machinery; (b) list of testimonials from users of traction engines; (c) little book entitled "Hints to Purchasers" giving principal points to be looked for in traction engines.

The Metallic Valve Co., 69 Tower Bldgs., Water St., Liverpool, England.=Illustrated catalogue, testimonials and list of users of Kinghorn's metallic pump valves; describes two types, "multiple disc" and "flexible."

Palatine Engineering Co., Ltd., 10 Blackstock St., Liverpool, England.=Illustrated price list of

the "Deacon" waste detecting water meter and Lord Kelvin's water taps and steam valves; also of steam fittings, forges, hand pumps, vices, etc.

The Weldless Steel Tube Company, Icknield Port Road, Birmingham, England.=Price-list of weldless steel tubes for cycle purposes.

Latch & Batchelor, Ltd., Hay Mills, Birmingham, England.=Four page circular with illustrations, sections, description, strength and weight of wire ropes.

S. E. Norris Co., Shadwell, London, E.=Illustrated catalogue and price lists (*a*) of leather belting and belting accessories, leather laces, etc.; (*b*) of strap and harness leather; (*c*) of fire hose, gun metal appliances and leather and canvas fire buckets.

John Shaw Ltd., Soho Street, Sheffield, England.=Price-list of steel wire ropes and mining requisites, pulleys for rope haulage and steel tub wagons.

The Newton Electrical Works, Ltd., Taunton, England.=Well printed and illustrated catalogue of the "Taunton" dynamos and motors, also of electrical haulage plants, switchboards and combined electric lighting plants.

A. and Z. Daw, 11 Queen Victoria St., London, E. C.=Catalogue of the "Daw" rock drill, the "Daw" air compressors, and other quarrying machinery. List of testimonials, telegraphic code and illustrations accompany each specification.

James Coultas, Perseverance Iron Works, Grantham, England.=Price list of agricultural machinery, corn and seed drills, sowing machines and manure distributors.

The J. C. Nicholson Tool Co., Newcastle-upon-Tyne, England.=Illustrated catalogue of machinery divided into six sections describing (1) treadle lathes, (2) screw cutting lathes and drill chucks, (3) drilling machines, (4) planing, shaping and other machine tools, (5) engineers' and shipbuilders' tools and (6) engineers' hand tools. Full descriptions, dimensions, weights, prices, etc.

The Pulsometer Engineering Co., Ltd., Nine Elms Iron Works, London, S. W.=*(a)* Illustrated catalogue of the Pulsometer steam pumps, devoted principally to the conditions in which it can be advantageously employed; *(b)* Pamphlet entitled "A chat about a successful invention" giving further particulars of the pulsometer pump.

Barrows & Co., Banbury, Oxfordshire, England.=Catalogue of street water carts, street sweeping machines manure distributors and chain pumps. Fully priced and illustrated.

Colledge & Bridgens, Church Lane, Wolverhampton, England.=Comprehensive price list of locks, door handles and a general line of iron and hardware supplies including safes, pumps, bath tubs, cisterns, etc.

Webb & Sons, Stowmarket, Suffolk, England.=Price list of leather machine belting.

Hildick & Hildick, Walsall Tube Works, Wal-

sall, England.=Price list of wrought iron tubes and fittings.

Thomas Withers & Son, Phoenix Works, West Bromwich, England.=Price list of wrought iron fire and burglar proof safes, doors, etc. Fully illustrated.

Richard Simon, Nottingham, England.=Circular descriptive of grain dryers, refrigerators, automatic weighers, and sack-filling machines.

Billington & Newton, Longport, Staff.,-England.=Circular descriptive of "Cookees" automatic governor stop valve. Illustrated.

S. Corbett & Son, Wellington, Shropshire, England.=Illustrated and descriptive price list of the "Plymouth" grinding mills for agricultural purposes.

Pearson's Automatic Fire Indicator Company, Ltd., 100 St. Martin's Lane, Charing Cross, London.=Small pamphlet describing this indicator, which works on closing an electric circuit.

Woodroffe & Co., Rugeley, England.=Catalogue of steam engines and combined engine and boiler plant; also of shafting, belting, etc.

Lincolne & Co., 67 North Wallace St., Glasgow.=Circulars describing (*a*) "Tilestoneite," a heat-resisting, rain proof covering for roofs, walls, etc.; (*b*) "Dryasdust," non-conducting composition.

The Phosphor Bronze Co., Ltd., 87 Sumner St., Southwark, London.=*(a)* Well-printed catalogue of phosphor bronze, Duro metal, phosphor tin, Bull's metal, plastic metal, silicium bronze, and other alloys. with results of tests, full instructions for use, and testimonials; (*b*) Pocket edition of the same with condensed particulars.

R. G. Ross & Son, Greenhead Engine Works, Glasgow, Scotland.=*(a)* Catalogue of steam hammers and cranes. The steam hammers are Rigby's pattern, the cranes are principally wharf, forge, and foundry patterns. A machine for flanging boiler plates, and a radial steam hammer are also described; (*b*) Circulars describing Ross' patent caulking tools, portable pneumatic drilling machine, patent speed reducing and increasing gear, and Ross patent rock drills.

T. S. McInnes & Co., Ltd., 41 Clyde Place, Glasgow, Scotland.=Price list of steam indicators, gauges, engine counters, calorimeters, etc., with directions for using, illustrations and testimonials. 24 pp. 5 1/2 x 9 inches.

McArthur & Jackson, Glasgow, Scotland.=Pamphlet entitled "Lubrication and Lubricating Oils," giving information on colour, smell, specific gravity, fluidity, flash point, and gumming of oils.

John Davis & Sons, All Saints' Works, Derby, England.=*(a)* Catalogue of surveying, engineering, mathematical and meteorological instruments and miners safety lamps, with illustrations, prices and other particulars; (*b*) Circular price list of electric blasting apparatus; (*c*) Illustrated description of the Jeffrey electric long wall coal cutter.

THE ENGINEERING MAGAZINE

VOL. XV.

SEPTEMBER, 1898.

No. 6.

THE ESSENTIAL ELEMENTS OF MODERN SEA-POWER.

AN AUTHORITATIVE REVIEW OF ENGLAND'S NAVY AND SHIP-BUILDING
PROGRAMME.

By Vice-Admiral P. H. Colomb, R. N.

A SIGNIFICANT feature of the times is the concentration of interest everywhere upon naval construction. The Spanish-American war has made clear the incalculable value of a strong navy in keeping peace—a function more important than that of establishing a victory. With England the question of naval power is always paramount, and to her navy is generally conceded mechanical, as well as military, preëminence ; but some strong notes of alarm have been recently sounded in regard to the material condition of the British navy in comparison with the navies of France and Russia. The loudest, and strongest note, as can be immediately seen, is struck on the ground that it is fair criticism to leave out of the account the most numerous class of British war ships, the protected cruisers, which absorb more tonnage than any other class, except the battle-ships. The principal claim is to make an enormous addition to the battle-ships and to the armoured cruisers, and the assumption behind it is that England is bound to adopt a ship-for-ship policy, ignoring strategical and tactical considerations. We should, in fact, count noses, as if the future rule of war will be that the whole of our fleet, and the whole of the fleets of France and Russia, will proceed into mid-Atlantic and there fight it out, class against class and ship against ship. I think it is quite time that that system of criticism should be dropped. It may be proper, when our navy has been allowed to fall behind by neglect, to carry out a ship-for-ship policy until a level has been reached ; but then, considering that the classes, and proportionate classes, built by one power, are not necessarily those which meet the

Copyright, 1898, by John R. Dunlap.

wants of another power, we should carefully study the general strategical and tactical conditions, and build accordingly. Our idea would be "to develop the accepted principles which should appear in the formation of a really powerful navy."

The admitted final aim of our naval policy is to maintain a force which will match the navies of France and Russia, or any pair of the strongest naval powers that may be combined against us in war. The actual result is that we aim at somewhat overmatching any two such powers; and, before we can aver that the admiralty is lax in any particular, we must have some idea of what the whole force on each side is. Then, by considering some of the principal strategic and tactical conditions under which we must fight, if we fight at all, we shall ascertain how far the ships we are possessed of will be available, and therefore what will be our real comparative force, should war break out.

Though the Return No. 206, of May 17, 1898, is not as complete as could be wished, we must found ourselves upon it, as it must be taken to represent the admiralty case. The classes of ships dealt with in the return are battle ships, cruisers, coast-defence vessels, special vessels, and torpedo craft. We must, I consider, never lose sight of the fact that there are only three strategic conditions under which our ships can be used: (1) where we operate in the enemy's waters; (2) where the enemy operates in our waters; (3) where the sea is left open to both sides, and at one point we are operating in the enemy's waters, while at another point he is operating in our waters,—or, in more technical language, where "the struggle for the command of the sea" is in full progress. It will not, I think, be contested that our hope and our aim must be to start with, and to maintain, the first condition; and the interest in the inquiry will be to discover whether or not we are now ready, and promise in future to be ready, to do so.

The return divides the whole of the forces into the two conditions—built and building. It is common, in drawing comparisons, to mix up the two conditions. Nothing could be more confusing. The one condition exhibits past policy, and the other present policy. The comparison, even when confined to ships built, must be faulty, because of the different conditions of readiness under which the ships are counted. But it seems a gratuitous introduction of confusion to count side by side a ship ready for sea and another ship whose keel is but half laid.

We may fairly leave out of the general account the coast-defence ships, on each side, because they cannot generally operate against one another. If we were operating in the enemy's waters, our coast-defence ships could be used only in exceptional cases, and, if the enemy

were operating in our waters, the like would happen to his coast-defence vessels. We can also leave out the special vessels, only one of them—the *Vesuvius*—being a fighting ship. The remaining ships built, then, naturally divide themselves into two groups, one of which bases its offensive power primarily on the gun, and the other primarily on the torpedo. We then get for the gun ships the following :

Powers.	Nos.	Displacement.	
		Total Tons.	Average Tons.
Gt. Britain.....	181	1,122,408	6201
France	82	419,373	5114
Russia.....	28	205,833	7531
F & R	110	625,206	5683

Showing that, looked at in this general way, Great Britain has 64 per cent. in the numbers of her gun-ships, and 79 per cent. in their displacement, more than the combined possession of the two powers. But, as the displacement of our ships is so much greater, an allowance in numbers must be made in fairness, and that gives us the equivalent of 197 gun-ships to their 110, or 79 per cent. more.

The torpedo craft stand thus in the total :

Powers.	Nos.	Displacement.	
		Total Tons.	Average Tons.
Gt. Britain	183	49,792	272
France	224	27,620	123
Russia.....	135	25,987	191
F & R.....	359	53,607	150

Our past policy is exhibited here, for we show a deficiency both in numbers and displacement, due entirely to our ceasing to build torpedo-boats, and building instead torpedo-vessels and destroyers.

I am not going into the question either of speed or of coal endurance. It is common to claim that, if two ships come into action, or if two squadrons come into action, equal in all respects except in speed, then the slower ship or squadron is at a disadvantage. It is by no means generally true. Tactically, reduction of speed is advantageous in as many cases as is increase. Strategically, the higher speed is generally an advantage, but, as will be explained, it does not so much affect the strategy that we must adopt in war with France and Russia. In the same way, coal endurance, of no importance in tactics, but of great importance in strategy, does not so much affect the strategy we must adopt, where the coal will continually follow up the ships.

Reviewing our policy in this general way, we see that our aim is to have a greater number of larger gun-ships, but that we do not prepare for defending our own waters by torpedo-boats. France and Russia, looking on the torpedo-boat as the best defence of their home waters, where they expect to be attacked, keep a large stock.

We pass now to the gun-armament of the gun-ships, dividing it into heavy, to include the 7-inch and all guns of larger calibre; medium, to include all guns from 4-inch to 7-inch; and light, to include all other guns.

The following table summarises the comparative numbers and calibre of the heavy and medium guns in the gun-ships of Great-Britain, France, and Russia:

Powers.	Nos.	Calibre.	
		Total Inches.	Av'age Inches
Great Britain.....	2229	14,707.24	6.60
France.....	927	6,011.80	6.48
Russia.....	337	2,411.60	7.15
F. & R.....	1264	8,423.40	6.66

This table shows us that our gun-ships carry 76 per cent. more heavy and medium guns than those of France and Russia combined. But, as the average calibre of our guns is somewhat less than that of the other powers, our numbers must be regarded as the equivalent of 2,208 guns, to their 1,264, or 74 per cent. more.

In light guns our gun-ships carry 3,335 guns to 2,031 carried by France and Russia, leaving us, therefore, superior by 64 per cent.

It is clear that, apart from any question of strategy, these ships, battle-ships, armoured cruisers, protected cruisers, and unprotected cruisers, form the bulk of the fighting forces on each side; and, if the figures are reasonably correct, we have, on the surface at least, a very large preponderance of force.

Turning to the torpedo craft, we find on our side 70 medium guns, averaging 4.72 inches' calibre, while France and Russia show 26 medium and heavy guns of 6.69 inches' calibre, leaving a margin of 23 guns on our side. In light guns we show about 796 guns to their 911. Perhaps our superiority in one kind of guns may be held to balance the deficiency in the other.

The torpedo-tubes on our side, in the torpedo craft, count about 583, while France and Russia have about 710. But torpedoes do not count much as weapons among torpedo craft. It depends entirely on the strategical view taken whether the deficiency is real.

No doubt this way of looking at the whole of the navies in bulk will be objected to. I submit that we cannot get a true view, unless

we at least begin in that way. Those who consider it a mistaken method are bound, I think, to show how it is to come about that only class will fight against class, in the face of the experience of the two latest steam wars, our only practical sources of information as to the present conditions in action.

Descending to particulars, we may consider the battle-ships and armoured and protected cruisers separately, omitting the unprotected cruisers. For the battle-ships we get this table :

Powers.	Nos.	Displacement.	
		Total Tons.	Average Tons
Gt. Britain	52	549,360	10,564
France	27	226,760	8,398
Russia	12	117,240	9,770
F & R....	39	344,000	8,820

That gives us 34 per cent. superiority in numbers ; but, as our ships are so much larger, our real superiority is 62 ships, or 58 per cent.

The heavy and medium gun armaments of the battle-ships stand as follows :

Powers.	Nos.	Calibre.	
		Total Inches.	Av'age Inches
Gt. Britain	654	5145.00	8.02
France.....	353	2634.10	7.45
Russia.....	146	1206.80	8.26
F & R.....	499	3840.90	7.69

This gives us a preponderance of 31 per cent., but, on account of the larger calibre of the guns, the equivalent is 32 per cent. In light guns the numbers are: Great Britain, 1,451; France and Russia, 1,000,—a preponderance on our side of 45 per cent.

The armoured and protected cruisers stand thus, in number and displacement :

Powers.	Nos.	Displacement.	
		Total Tons.	Average Tons
Gt. Britain.....	113	528,830	4679
France.....	39	144,804	3712
Russia.....	13	80,193	6168
F & R.....	52	224,997	4326

This gives us a preponderance of 117 per cent. over France and Russia ; but, as our ships are larger, the real preponderance is 122 per cent.

The heavy and medium gun-armaments stand thus :

Powers.	Nos.	Calibre.	
		Total Inches.	Av'age Inches
Gt. Britain.....	1224	7242.92	5.91
France	333	1933.70	5.80
Russia.	150	1138.80	6.32
F & R	513	3072.50	5.98

This gives Great Britain a preponderance of 138 per cent., but, the calibre being a little less, her real preponderance is 134 per cent. In light guns the numbers are: Great Britain, 1,707; France and Russia, 845,—a preponderance on our side of 102 per cent.

Now we are in a position to consider what deductions may appear to diminish the great preponderance that the figures everywhere show on our side, except in defensive torpedo-craft and their armament. It is the practice in making comparisons to strike off altogether from our side considerable numbers of the battle-ships and of the armoured cruisers, on the plea that the patterns are obsolete, and many of the guns muzzle loading. Now, as I have observed, the practice is extended to striking off the whole of the protected cruisers. It may be said once for all, on this latter point, that there is no justification for so acting. The admiralty policy of counting armoured and protected cruisers as one body is clear. The admiralty have evidently held for a long course of years that a protected cruiser, equal in all respects except in the disposition of her armour, is a fighting match for the armoured cruiser. We have deliberately built protected cruisers as the answer to armoured cruisers; and we have only just entered on the policy of building cruisers with belt armour, with the special idea of their fighting battle-ships.

It is, however, quite legitimate to declare that old-pattern ships and old pattern guns cannot be put on an equality with the newest ships and the newest guns. But it is only after we have seen what nominal preponderance we are dealing with that we are in a position to apply a reasonable discount. To ignore altogether many ships and many guns is to assert that such ships and guns will not be sent to sea, even in the most pressing emergency of war,—a thing which cannot be reasonably asserted.

If we struck out altogether the 23 second- and third-class battle-ships, for instance, we should still be left with 29 of the most approved type, averaging 12,996 tons' displacement, carrying 401 guns of 7.84 inches' calibre, on an average, against France and Russia's total of 39 ships, averaging 8,820 tons, and carrying 499 guns

averaging 7.69 inches' calibre. Allowing for excess in displacement and calibre, we show an equivalent of 42 ships carrying 409 heavy and medium guns, which leaves us a preponderance in ships, and a deficit of only 19 per cent. in guns. But the displacement of the 23 second- and third class cruisers allows us to add 18 ships to the preponderance of 3 that we have already shown. And then, taking only the breech loading guns carried in the inferior battle-ships, we show the equivalent of 106 guns, to add to the 409 guns given above, making 515 guns to France and Russia's 499. Looked at from this point of view, we must say that the whole of the inferior battle ships, and the whole of the muzzle loading guns, can be treated only as preponderating margin, if the battle-fleets of Great Britain and of France and Russia are to be compared. The muzzle loading guns in the inferior battle-ships number 135, averaging 10.05 inches' calibre.

I have already dwelt on the impossibility of admitting that armoured cruisers can properly be counted as apart from protected cruisers. The admiralty policy on this head is too plain. With us, taking armoured and protected cruisers together, we find 84 per cent. protected; with France, 76 per cent. are protected; with Russia, only 23 per cent. Perhaps 9 of the British armoured, and perhaps 11 of the British protected, cruisers are of inferior type; and, of their guns, 166, averaging 7.92 inches' calibre, are muzzle-loaders. But the points cannot be laboured when we are dealing with a preponderance on our side of about 70 ships and 659 guns.

The real question now at issue is whether the method I have adopted is a sound one. I am bound to say that, in any case, it is sounder than that sometimes adopted, where, the object being to prove inferiority on our side, whole classes are omitted, and others, such as battle-ships, armoured cruisers, and coast-defence ships, are grouped together as if there were some connection between them, when there is absolutely none. It is seen that, basing myself on what has taken place in the Chino-Japanese and Spanish-American wars, the old conception—which I used to hold as strongly as any one—that only battle-ships can fight battle-ships has passed away. There does not seem any doubt that all battle fleets will, if the necessity arises, be supplemented by armoured or protected cruisers which will take their places in any battle-formation that may be adopted. But, while I think we must look at navies in this general way, my method does not show us to be inferior, even if it should be admitted that the heavy cruisers will not play a part in a general action.

Space forbids me to give a full account of the results arising out of the method I adopt, but, having adopted it, I must now briefly show what I conceive our strategy must be in a war with France and

Russia, and how our forces may be expected to work into it. I should like to say that I know of nothing to alter my strongly-expressed view that the torpedo-craft, as opposed to the gun-ship, is altering, and will still more alter, our views as to the battle-ship. It may be thought to be far-fetched, but I claim that the advance of the torpedo-craft has had a hand in producing the Cressy class of armoured battle-cruisers. Many months before the intention of building such ships was announced I had written it down that I was sure the next move would be to produce such ships; and by far the most important event of the Spanish-American war has been the production of the report of the United States board of survey on the wrecks of Cervera's squadron. The submission that "no torpedoes should be carried in fighting vessels"—that is, in gun-ships—will surely tend to separate gun and torpedo warfare; and the declaration that "rapid-fire batteries in battle-ships are of supreme importance" is, to my mind, only another way of saying that the four very heavy guns which have come to be the one distinguishing feature of the battle-ships are not of that preponderating value which we have all set upon them.

I have suggested that, if war were to break out between ourselves and France and Russia combined, our aim would be to keep the war in the enemy's waters; evidently we can do that only by "masking" the forces of the enemy, wherever they are found, when war breaks out. With Russia, this can mean only that we should desire to block her ships in the Baltic and the Black sea, and in such of her war ports—as Vladivostock, and now Port Arthur—as exist abroad. As to France, we should desire to block her ships in their separate ports, as Cherbourg, Brest, L'Orient, Rochefort, and Toulon, and in ports abroad, such as Saigon and Diego Suarez. All French and Russian ships in neutral ports would be "shadowed," as has been the practice with Russian ships in all the Russian scares. We should aim at doing on a large scale with all the naval forces of France and Russia what the United States did with Cervera's squadron at Santiago.

Speaking generally, we might assume that at first we should make no attempt to pass into the Baltic or the Black Sea, as we should make no attempt to press into French ports, and as Sampson made no attempt to pass into the harbour of Santiago. The point still debated and unsettled is whether the heavy ships would be placed as watchers as well as maskers,—that is, close off the points of exit that would be used by the enemy,—or in the nearest convenient ports, as maskers only, not in actual touch with the enemy, leaving the watch to be done by light ships and torpedo-craft. I think the latter plan would be adopted, and its full success would depend on the nearness of the anchorage to the point of exit, and the sufficiency and efficiency of

the light watching squadrons. It is evident, I think, that, by treaty and alliance with the northern powers, we should acquire the right to use the more convenient anchorages at the entrance to the Sound and the Belts, and here we might place our heavy ships. A glance at the chart shows that it could be made perfectly hopeless for the Russians to get to sea without being brought to action; and, if our masking force were only somewhat superior, there could be no motive for the Russian fleet to attempt to pass to sea. The fate of Cervera's squadron will leave its mark here, for the Russian admirals would be quite aware that, whatever motive there was for putting to sea, it could not exist after the battle, however the battle might terminate. The chart assures us that the widest of the three passages available for the Russian ships is only three miles across.

It becomes evident that neither speed or coal endurance would have to be considered in selecting ships to bar these passages; it has been generally understood that even our coast-defence ships would have gone to the Baltic, if necessary, had Russian scares developed into war. I cannot doubt but that these would still take part in blocking the channels mentioned, and that, so long as we did not propose to pass into the Baltic, the guarding of these passages might be safely confided to a sufficient number of the so-called obsolete battleships and armoured cruisers. These ships themselves would undertake the watch, and the light ships and torpedo-craft would be left available for duty elsewhere. I take it that the British heavy ships masking the French northern ports would be found perhaps at Dover, and at Portsmouth, Portland, and Plymouth; while the lighter cruisers, the torpedo vessels, and the destroyers, would undertake to watch and to report in time to the parent masking fleets. There is almost a general understanding that, for the masking of Toulon, the fleet would be stationed at Gibraltar, and that then a sufficiency of light vessels and torpedo craft would watch, and report from, Toulon, if, under such conditions, we can assume French fleets putting to sea. But I own that I find great difficulty in supposing anything to tempt them, so long as the masking squadrons were superior. It is plain that escape would be attempted only by the ships having the highest speed and coal endurance. If they did succeed in evading, a like selection from the Gibraltar fleet would be left to deal with them.

Apart from treaties with Turkey, anchorage would be found in the vicinity of the Dardanelles, where the masking fleet might be stationed, either in direct watch upon the entrance, or leaving the watch to lighter vessels. The foreign ports would be left to be dealt with by our ships already in those waters,—reinforced if necessary.

Any one can see that our nominal margins of preponderance be-

come real, as soon as it is observed how the older classes can undertake the blocking of the Baltic, and then it is easy to show a sufficient preponderance in the rest of the masking fleets, even allotting cruisers for the protection of commerce against such ships of the enemy as escape the watch set upon them.

If I am right as to the general employment of our ships on the outbreak of war with France and Russia, and if I show that, even as we stand, we have sufficient forces for the purpose, a very few words will suffice to deal with the building programme, because it becomes necessary to show only that ours keeps pace with the programmes of France and Russia.

All these countries have agreed not to build more unprotected cruisers, coast defence vessels, or special vessels. England and Russia have ceased to build torpedo-vessels, Russia never having shown affection for that class of ship, and France having so far forsaken the type that she is building only two. All these countries are building destroyers. England is building forty-six, and nearly doubling her stock, and France is beginning with eight where she had none before, while Russia is adding twenty-eight to the one she already possesses. Neither England or Russia is building torpedo-boats, but France is adding thirty-eight to her already large stock. On the other hand, all three countries are building battle-ships,—England twelve, France eight, and Russia six. It is not, therefore, unreasonable to suggest that we might lay down two more, to be on the safe side, unless we take into account that the average tonnage of our ships is 13,633 tons against the 12,179 of France and Russia, and unless we count the Cressy class as practically battle-ships. All three countries are building armoured cruisers,—England eight, France ten, and Russia one. All three countries are building protected cruisers,—England twenty-four, France ten, and Russia three. We are therefore building thirty-two cruisers against the twenty-four that France and Russia are building. We are maintaining our policy of having the larger number of larger ships, our armoured and protected cruisers averaging 7,485 tons, while those of France and Russia average 7,005 tons.

As a conclusion, I think we may say that there is nowhere in our ship building policy and condition any cause for alarm. Without doubt we must continue to exercise vigilance and forethought, but I am as convinced as ever that this is exactly the wrong time for urging sensational programmes, especially in the matter of battle-ships and armoured cruisers. The Spanish-American war has left us just where we were in the matter of the value of torpedo craft, but I hold it to be there, more than anywhere else, that we require to remain awake.

ENGINEERING LESSONS FROM THE HISPANO-AMERICAN WAR.

MECHANICAL SUPREMACY THE VITAL FACTOR IN NAVAL SUCCESS.

By Hiram Stevens Maxim.

IN the days of the Roman empire the implements of war were simple in the extreme, and the northern barbarian, with a few hours' training, often proved himself more than a match for the best Roman soldier. When the instruments of warfare were simple and easily understood, the rich and civilised nations had but little advantage over the poor and uncivilised tribes. The advent of gunpowder, however, brought into use an instrument of destruction much more complicated and difficult to understand than the old two-edged Roman sword. Moreover, the use of fire-arms required a higher degree of intelligence, and the manufacture of the arms and powder required both mechanical and chemical skill of no mean order. This was the first step which gave the civilised nations a decided advantage over an uncivilised foe. Moreover, guns and ammunition were found to be much more expensive than spears, swords, or bows and arrows. This again proved to be a great advantage to the civilised nations. With the old sword there was little chance of improvement; it was simply a piece of tempered steel provided with one or more edges, the length depending upon the taste of the nation employing it. But the gun, being a more complicated instrument, was susceptible of many improvements. The nation most skilful in the manufacture of iron and steel would naturally be possessed of the best fire-arms, and in all probability the great advance which Europe has made in the mechanical and engineering arts is due in no small measure to the competition in the development of fire-arms.

When the English and the Spaniards met three hundred years ago, it was found that the English ships, although small, were better built than the Spanish, and could outsail them. Moreover, the English sailors possessed greater skill than their enemies in the management of the ships, while the English gunners were superior at all points to their Spanish enemies. Nevertheless the Spaniards were able to inflict very heavy losses upon the English. The fights between the Spanish and the English in those days were not always one-sided affairs. The ships and guns employed were very primitive, and comparatively little skill was required for their management. Nevertheless the slight advantage in skill possessed by the English nearly always brought them victory.

In the olden time, when international commerce was almost unknown, it was generally necessary for each nation to manufacture

its own arms ; thus the mechanical skill of a nation was a determining factor in warfare. At the present time, however, every nation or tribe, no matter how uncivilised, can purchase the best arms, if able to pay for them. If, for instance, to-day 10,000 Turks should meet 10,000 Frenchmen or Germans in the open field, it would be a toss-up as to which would win, with the odds, if anything, in favor of the Turks ; but, if the Turks should employ only such instruments of warfare as they are able to make themselves, they would have absolutely no show against other European troops. But this relates only to arms comparatively easy to understand, such as rifles and field artillery. When, however, we come to the navy, which is distinctly several grades higher, we find that, no matter how perfectly a warship may be constructed, and no matter how accurately the arms may be made, the Turk is not sufficiently mechanical and technical to understand and take charge of them. He cannot even be taught the necessity of cleanliness and order ; the engines and boilers are allowed to rust, and the hulls become covered with animal and vegetable growths, until the ship and its armament are comparatively worthless for the purposes for which they were constructed. If such a ship, manned and navigated by Turks, were to meet a French or German ship of equal size, the combat would be of short duration, as the Turkish ship would speedily be rendered *hors de combat*.

Sea-fighting has changed completely since the days of the Spanish Armada. It is also entirely different from what it was in the days of Nelson. Instead of the wooden ships of the olden time, armed with cast-iron or bronze smooth bores using spherical ammunition, we have the modern cruiser and battleship. It is said that the Oregon, which may be considered one of the best types of modern battleships, is provided with about 100 steam engines, used for different purposes. Moreover, there is an extensive electrical plant. The manufacture of the vast and intricate machinery that one finds on a battleship of this kind requires an immense amount of skill, and the intelligent operation and care thereof require almost as much more. It does not require much skill to manipulate light projectiles, but it evidently requires a high order of skill to understand and work apparatus for moving heavy projectiles and charges by means of steam or electricity.

The Spaniards were able to purchase some of the best cruisers in the world. They were also able to provide themselves with a considerable number of torpedo boats and torpedo-boat destroyers. Several of these were made in England. The machinery in them was of the highest order known to modern steam engineers. The Spaniards were also able to purchase excellent guns and ammunition. The Americans, on the other hand, built their own ships and made their

own guns, and the very fact that they were obliged to do this gave them the necessary skill in their management afterwards. Five or six large cruisers which Spain had at the beginning of the war were supposed to make from twenty to twenty-one knots per hour. Now, in order to make this speed, it was necessary that the hulls should be clean and smooth, that the boilers and grates should be clean, that the coal should be of good quality, and that the engines should be of the highest degree of efficiency. Had these ships been in the hands of engineers such as may be found in England, the United States, or Germany, they doubtless would have developed a speed very nearly equal to that claimed for them. When, however, they were taken possession of by the Spanish engineers, everything apparently was neglected. The hulls were allowed to become foul, and the boilers to get completely out of order; the engines did not receive the proper care; the stokers did not possess sufficient skill to keep up the steam pressure; hence, instead of twenty to twenty-one knots, they could make but fourteen or fifteen.

It was expected that this powerful, swift fleet of armoured cruisers would do a great deal of damage to the American coast. It was claimed at the time that the Americans had but one ship which was their equal in both speed and armament,—namely, the *New York*. It was believed in Europe that the Spanish cruisers could run away from the American battleships, and outfight the American cruisers.

When I was in Paris at the beginning of hostilities, nearly everyone said that the Spaniards would have altogether the best of it for the first five or six months; that the American fleet would be practically annihilated; and that probably New York and Boston would be bombarded. When I expressed my opinion that in all probability no Spanish ship would get farther north than Cape Hatteras, they shrugged their shoulders, and said: "Very well, we shall see." I was assured by a number of Spanish sympathisers that the Spaniards would be sure to give a very good account of themselves. A great deal was said about the Cape Verde fleet. A great deal was also said about the torpedo-boat destroyers, and so forth. Some of the English papers, speaking of the Spanish fleet of torpedo boats, said it had caused perfect consternation in the American navy. It was said that the Americans would probably win in the long run, but that the United States was a much bigger target than Spain, and the Americans had begun to appreciate it; that the Americans stood a very poor chance against the highly-trained Spanish regulars, and the powerful cruisers with which Spain was so liberally provided.

Let us see now what actually took place.

The much-vaunted Cape Verde fleet at last sailed. This was sup-

posed to strike terror into the hearts of the Americans. Very little was heard of this fleet for a long time. Then we learned that only a few torpedo boats had succeeded in crossing the Atlantic. Next we heard that one of the destroyers was left at Porto Rico. And finally we found that the whole of Cervera's fleet had succeeded in entering Santiago harbour,—an event which was held up as marking a great and glorious day for Spain.

The next important event was the attempt of the Spaniards to escape. They had noticed that the Americans held religious services on Sunday morning; they believed that steam pressure would be low, on the American vessels, and that they might be caught napping; moreover, the swift New York, which they feared most of all, was ten miles away. This seemed an excellent opportunity to escape. It was said that the cruisers were able to go about five knots per hour faster than the American battleships, and it appeared to the Spaniards that they stood a very good chance to shew them a clean pair of heels with the exchange of but a few shots. When, however, they came out of harbour, it was found that only one of their ships, the "Cristobal Colon," was able to go faster than the American battleships, and they very soon found themselves paired off with American ships fast enough to be able to choose their own range. By taking advantage of the superior skill of the American gunners at long range, the Americans were able to annihilate the Spanish fleet in a short time, with practically no loss to themselves. But it may be said that the American battleships were infinitely stronger than the Spanish cruisers. This certainly cannot be said in regard to the triangular fight between the two powerful Spanish torpedo-boat destroyers and the little American yacht, "Gloucester." Sidney Low, writing in the *Pall Mall Gazette*, after speaking of the total destruction of the Spanish fleet with practically no loss on the part of the Americans, points out that the determining factor is the man who fires the gun, the man who wings the torpedo on its way, the man who pulls the lever in the engine-room, the man who has the nerve and skill to use the ram. If he is not capable and resolute, all the rest is nothing. Speaking of the Gloucester, he says :

The Gloucester's fight with the two torpedo-boat destroyers is enough to make one distrust all paper calculations for ever. Theoretically, Lieutenant Wainwright's vessel should have been a sinking wreck five minutes after she had the temerity to challenge the *Furor* and the *Pluton*. The American vessel was a lightly-built yacht, hastily turned into a warship by having a few six-pounders and three-pounders mounted on her decks. The two destroyers are supposed to represent the very latest results of modern naval architecture. They were built in English dockyards, and they are fitted with enormously powerful engines, which are supposed to give them a speed of twenty-eight or thirty knots an hour—ten knots at least faster than their victorious antagonist. They carried fourteen-pounders, six pounders, and Maxims, and,

according to certain of our authorities, two or three of them ought almost to be a match for a battleship. But the yacht simply smothered them with her well-aimed gun fire, and drove them ashore in flames, without receiving a touch herself! It is a most astonishing triumph of mind over matter—of skill and spirit and judgment over men handling immeasurably superior weapons and lacking the capacity to use them effectively.

The American gunners had been highly trained; large sums of money had been expended in ammunition to be used in target practice at sea. Every man knew his gun, and had confidence in himself while the greater part of the Spanish gunners probably fired the large guns of their fleet on the morning of the action for the first time.

There can be no question that the Spaniard individually has quite as much personal bravery as the American, but he has no taste for machinery, is not an engineer, and is completely without the skill which is necessary in order to understand and handle the ponderous and complicated machine that one calls a battleship or cruiser of to-day. Hand-to-hand sea-fighting is a thing of the past; naval battles are engineering conflicts between machines, and the man who understands these machines best is the man that is sure to win.

Before the battle of Manila the Spanish government seemed confident. They pointed out that they had more ships at Manila than the Americans could possibly bring against them; moreover, the place was well fortified. However, early one morning they found the American fleet in the bay, and it very soon engaged all their ships while lying under the guns of the fortifications. Notwithstanding that the Spaniards in their fortifications and ships had considerably more guns than the Americans, the fight was of short duration, the Spanish fleet being destroyed in a very short time, while not a man was killed on the American side. Here again we find that the Spanish ships and guns were in a wretched condition; everything had been allowed to go to ruin; the gunners seemed quite unable to hit anything. On the American side, on the contrary, everything seemed to be perfect; nothing was out of order; and Admiral Dewey, in writing, speaks of the care that had been taken in training the gunners, and of the gratifying results from the high character of the men employed and the careful training they had received. Here again it was a triumph of technical skill and high training over a complete lack of skill and what one might call criminal negligence on the part of the Spaniards.

The Spanish officers and gentlemen are as intelligent and as refined as those of any country; many of the merchants and bankers conduct their business with great skill and care, and accumulate large fortunes. In no part of the world are there greater integrity and honesty in commercial transactions than in Spain; no merchants stand

higher than the Spanish. In literature they are perhaps superior to ourselves, while in art they have far surpassed us; but they have no taste for engineering, and it is impossible for them to appreciate the necessity of taking good care of machinery.

The Spanish and French newspapers, at the beginning of the war, referred to the United States as a nation of *commerçants* and pigstickers. Had they referred to them as a nation of engineers and skilled mechanics, they would have been much nearer the mark. If there is anything in the world which distinguishes the American, it is his taste—may I say his love?—for the mechanical arts. All the young men are extremely fond of machinery; they all wish to make something,—to build a steam engine or a boat, or to make a gun; and it is this which gives the American, and the Anglo-Saxon everywhere, an advantage over the less skilful nations of the world.

The complication of modern implements of destruction gives to the highly scientific and mechanical races a marked advantage over the untrained and unscientific nations. The greater the complication, so long as advantages may be derived from it, the greater the skill required to understand and use the instrument, the greater the supremacy to be derived from its use. I think it may almost be said that naval warfare has reached so high a degree of development and requires such a mass of intricate and complicated machinery as to render it completely useless to unscientific nations. The wisdom of a government in insisting that everything relating to warfare should be constructed in its own country is apparent. If a nation make its instruments of warfare, it will certainly be able to use them.

The war has taught us, too, the small value of torpedoes as compared with heavy artillery. Many naval engineers have contended that the torpedo boat would be much less dangerous in actual warfare than was supposed, and the war seems to sustain their view.

I think the war has also shown that the heavy gun throwing steel projectiles at a very high velocity, so as to have a flat trajectory, is the arm *par excellence*, the arm which we must depend upon in naval warfare, and that thick and heavy armour-plate more than compensate for the additional weight and loss of speed involved. It has also shown the great value of battleships as compared with cruisers,—that is, in a pitched battle; but it has not shown that cruisers are unnecessary. Had the Spanish cruisers been well cared for and well handled, there can be no question that they would have inflicted very serious damage upon the American fleet, and, might perhaps have bombarded some of the coast cities. The war has proved that we should stick to high-power guns and the conventional forms of cruisers and battleships, and keep the navy free from cranks and fads.

EUROPEAN AND AMERICAN BRIDGE CONSTRUCTION.

By Gustav Lindenthal.

FEW engineering works so fill the beholder with wonder and admiration as a large bridge, a ponderous mass, supporting itself in mid-air, the embodiment of vast resistance and strength.

Visitors to the largest bridge in existence, the great steel cantilever bridge over the Firth of Forth, ten miles above Edinburgh in Scotland, or to the great Brooklyn suspension bridge in New York, rarely fail to have their emotions and love for the grand and colossal aroused. Curiosity is excited as to what past ages have achieved, and as to whether the future will produce still grander works in bridge building, and the conviction is natural that these monuments of human skill represent, more emphatically and more impressively than any other concrete achievements, the great strides of modern progress.

And it is true that the character of the large bridges in any age, or of any country, furnishes an accurate index of the character of its civilization and of its material wealth. Closely connected with the construction of great highways, and these again happening only when a nation has attained commercial or military prominence, bridge-building tends toward a broader humanization. It was always one of the great and noble arts; as such it was commemorated by the ancient Romans.

To them the erection of the first bridge over the Tiber at Rome, the oldest historical bridge in Europe of which we have any record, the famous "Pons Sublicius," was an achievement so important that its maintenance and the perpetuation of its glory were entrusted to a special order of priests, the "Pontifexes," and membership in this order carried with it high distinction in the councils of State. Its head was the "Pontifex Maximus," traditionally a title of greatest dignity to this day, having descended to the head of the Catholic Church, the order of bridge-builders thus antedating, and surpassing in honor, royalty itself.

This famous bridge, known also in history through its heroic defence by Horatius Cocles against the Etruscans, the subject of one of Macaulay's poems, was already one of great antiquity when that event took place. It was of hewn timber, resting on piles, and probably not more than six hundred feet long,—an inconsiderable structure, according to present ideas of size. It was rebuilt of stone in the seventh



THE FORTH BRIDGE

Steel cantilever; the largest bridge in the world. The two main spans are 1700 feet each. Carries two railway tracks; completed 1890.

century B. C., and in its place is now an iron bridge, the "Ponte Sublicio."

There were older and larger bridges in the oriental countries,—Babylon, Phoenicia, Egypt, and Greece,—but historical accounts give only scanty information of their construction; probably because, like other work done by slave labor, bridge-building was not considered, by these nations, deserving of fuller record and description.

Through all the ages, up to one hundred years ago, construction was governed entirely by empirical rules, transmitted by tradition. The tools were of the crudest kind (bronze tools, probably B. C.); the lifting of the heavy masses of timber and stone was effected along inclined platforms, and, like the pumping-out of the foundations, by human and animal power. But that, even with these meagre means, several master works were created is testified to by the remains of stone bridges, whose equals, in magnificence and grandeur, are not found in modern stone viaducts.

Thus the boldness and architectural beauty of the "Pont du Gard," at Nîmes, France, with its three stories of arches, together 160 feet high, and with openings of 80 feet, has withstood the storms, and has been the admiration, of nearly twenty centuries.

Nineteen hundred years is the age of the "Ponte Maggiore" in Rome, which to this day carries the aqueduct of the Aqua Claudia.

The conception, as well as the masonry and workmanship, of these

classical structures, shows a wonderful skill, rarely found in modern stone architecture, notwithstanding the infinitely greater mechanical and theoretical resources of to-day.

Through all the centuries following the destruction of the Roman empire, there was as little progress in bridge-construction as in the building of roads and highways. Most of the bridges built during the middle ages over the large streams in Europe were very poor structures, either of the pontoon type, or of fixed spans of framed hewn timber. Stone arches were also built, but so small were the building resources of those days that from fifty to ninety years were required for comple-



THE EAST RIVER SUSPENSION BRIDGE, NEW YORK

The second largest existing span, 1600 feet. The first steel wire suspension bridge; completed 1883.

tion. To that period belong the still-existing bridge over the Danube, at Regensburg (completed 1146); the first bridge over the Elbe, at Dresden (completed 1260); a fine bridge over the Rhone, at Avignon (completed 1188); at Lyons (1265); over the Mosel, at Coblenz (1334); and the famous stone arch bridge over the Moldau river, at Prague, in Bohemia, to build which required a longer time (145 years) than was required for the building of any other bridge in existence. The construction was mostly under the direction of monks, at that age the only preservers of learning and of Roman tradition.

The few large wooden bridges were primitive structures, held together with the fewest iron bolts, and were repeatedly burned down and rebuilt during the frequent wars. That they were popularly ad-



CAST-IRON BRIDGE OVER THE SEVERN AT COALBROOKDALE.
The first iron bridge in the world. Span 100 ft. 6 in.; completed 1777.

mired as masterpieces of the bridge-builder's skill I know from personal recollection of the long structures on piles and trestle piers, over the Danube, at Vienna and Linz. So it was also with the wooden and pontoon bridges over the Rhine. The largest wooden spans were built in Switzerland, where large timber was more plentiful than elsewhere, and some of these curious and very old structures, well preserved, are still in use. No advance was made in theoretical knowledge through all that time. Flat, segmental stone arches were first used at the beginning of the twelfth century, in place of the half circle invariably used by the Romans. It did not signify, however, a better comprehension of the strains in arches, since the Gothic form was also frequently used, theoretically the most unfit for bridges. The great bridges of our time are of a material which the ancient and mediæval nations considered too precious and too costly for anything larger than swords and armor. Bridges of silver and gold occurred to them, but bridges of iron and steel were not thought of in their highest flights of poetic imagination. They are preëminently the creation of our time, representative of the unprecedented power and greatness of the "iron and steel age."

England, rich in the natural resources for the making of iron, and the earliest large producer of it, had naturally the first iron bridge,

the so-often-mentioned bridge over the Severn river, at Coalbrookdale. It is one hundred and twenty years old, well preserved and in full use. It is of cast iron. Of the same material was the first iron bridge on the European continent, at Laasan, in Silesia, which is one hundred and four years old, and likewise in excellent condition.

The largest American cast-iron bridge is the Chestnut Street bridge over the Schuylkill river, in Philadelphia, built thirty-five years ago. Its architecturally-pleasing appearance is in great contrast to some of the utilitarian abominations built over the same river in later years.

Everywhere cast iron was the kind of iron first used for bridge-building, in imitation of the arch principle, in which the material is wholly in compression.

Soon also wrought iron came into use, and, on account of its great resistance to tension, appearing first in the form of the suspension bridge. To England also belongs the credit of having the earliest and largest bridges of this type. The fine chain bridge at Conway, and a larger one over the Menai straits in North Wales (built 1826), are in a high state of preservation.

Although it is probably true that India and China had the first suspension bridges formed of iron chains, they were very imperfect structures, compared with the above-named English examples.



BRIDGE AT LAASAN, SILESIA.

The oldest iron bridge on the European continent; 60 feet span; completed 1794.



CHESTNUT STREET BRIDGE, PHILADELPHIA.

The largest cast-iron arch bridge in the United States. Two spans of 180 feet each over the river Schuylkill; completed 1863.

The evolution of iron-bridge building was very rapid, particularly with the development of theoretical and mathematical knowledge, which was greatly stimulated by the building of railroads. So it came that the largest and most important bridge structures were built for them; and here again we find the fact that countries, like England and the United States, having the densest network of railroads, and also the largest and most important bridges, are in the van of civilization.

To the United States, however, belong the credit and distinction of having produced the first bridge of steel, that precious material which will forever mark our age in history as that of the greatest in human progress. This first monument of the steel age was the St. Louis arch bridge over the Mississippi river, built by James B. Eads and Henry Flad, now both dead. Not only did these masters choose a form of construction architecturally beautiful, and practically and theoretically one of great perfection, but, with rare good judgment, they selected, after the most painstaking investigation, steel of a hard quality as the best material, the strongest and most economical for long spans. In these characteristics, as well as in thoroughness and elegance of details, excellent quality of foundations, masonry, and workmanship, and ingenuity of methods used in its erection, this bridge belongs to the few modern structures which deserve to be termed classical; it is the true "*Pons primus*—



ILLINOIS AND ST. LOUIS BRIDGE OVER THE MISSISSIPPI.
The first steel bridge of the world. Spans 502 and 520 feet. 1868-1874.



BRIDGE OVER THE RHINE AT COBLENZ.

The first wrought-iron arch bridge; spans 300 feet; completed 1864.

chalybeius'' of the world. The design was so far in advance of its own time that it received the endorsement of but few contemporary engineers. It was ten years before the next steel bridge was built; but of all built since none equals it in constructive elegance or in excellence of material.

Many were the criticisms of the design at the time. Only a few could see that it was above comparison with the iron structures proposed in its place, and vehement were the predictions of its utter failure. So far from their coming true, it can be justly said that discriminating knowledge, or want of it, of the theory and practice which guided the construction of that noble structure will always furnish a reliable test of the ability and competency of the bridge engineer.

Endlessly varied are the forms of structures erected in the last twenty-five years, since steel was first used. There are now hundreds of large bridges over wide and deep rivers which otherwise would never have been bridged,—trusses, arches, suspension bridges, cantilevers, and drawbridges, possible with no other material. The great Brooklyn bridge (1,600 feet span), the longest in America, has been surpassed by the great Forth bridge in Scotland, with its two large openings of 1,700 feet each, carrying two lines of track, over which trains race without diminution of speed, and without causing the



THE GARABIT VIADUCT.

The highest iron arch bridge in the world, 380 ft. high, 542 ft. span, over the Truyère, in the south of France.

slightest tremor. This bridge will again be surpassed by the structure over the North river of nearly twice the span (3,100 feet) and eight times the capacity. But that still larger spans are possible is



BRIDGE OVER THE DOURO, PORTUGAL.

Two roadways, one on top, and one suspended below, arch span 566 feet; completed 1885.

the conclusion reached, by a commission of army engineers appointed by the United States secretary of war in 1894. Their report gives, for certain conditions, as the practicable limit of span, 4,335 feet. I have no hesitation in saying that, a bridge with a span of 6,000 feet could be built, for the heaviest trains at express speed.

Fantastic as it may seem, it is nevertheless true that, based on the theoretical resources of to-day, a steel bridge could be built over the Atlantic ocean, which would be perfectly safe, resting on anchored piers which the fiercest hurricane, or the heaviest steamer in collision,



BRIDGE OVER THE ADDA AT PADERNO.

The largest iron bridge in Italy; span 490 feet; completed 1889.

could not disturb, and with long spans so high above the water that the tallest vessels could safely pass under them. Financially such a bridge is impossible, because its cost would be greater than the combined free wealth of all the nations; and, practically, it would be absurd, because of no commensurate benefit to mankind. It illustrates, however, the vast progress in knowledge which eliminated from the modern bridge engineer's vocabulary the word "impossible," except in the sense that engineering possibilities are limited by financial possibilities, and by them only.

A mere description of all the great steel bridges already built would fill many volumes. But most interesting it is to notice the evolution of the type, nearest in kind to that of the stone arch, in which the carrying capacity is derived from the compressive strength



BRIDGE OVER THE SCHWARZWASSER CREEK, SWITZERLAND.

Largest arch bridge in Switzerland; span 380 feet. Completed 1882.

of the material. That the greater strength of iron and steel results in a light and graceful appearance is strikingly shown in the views herein presented. An arch bridge is always more pleasing than a truss or beam construction, which is, however, a most suitable form where mere utility is the leading consideration.

However grand the achievements in iron and steel bridge building may be in the future, one important fact will distinguish and limit their age from all others. In all probability, the steel age will be the shortest in history. It will end at a time, perhaps, no farther removed from the present than the present is from the time of the Crusades. In Europe and America, at least, steel bridges will be then creations of the past. This will be so, because, for the production of steel and iron in large masses, fuel in large quantities is necessary. Charcoal was the exclusive fuel and reducing agent, before mineral coal was used. Once the mineral fuels (coal, petroleum, natural gas, or their products) are exhausted, the production of iron must revert to the limitations of the charcoal period.

Authorities estimate that the coal-fields of Europe and America will last from four hundred to fifteen hundred years longer. Those of Asia and Africa are not yet fully known. Measured by the age of the Egyptian pyramids, the steel age will, therefore, be of short duration, but the most glorious in the history of mankind.

The expectation that progress in the sciences will discover new

ways of making iron and steel in large masses without fuel, or with very little fuel, cannot be fulfilled. Power for mechanical purposes mankind will be able to obtain from the four other great sources of nature (wind, tides, waterfalls, and the heat of the sun), but mineral fuel is the only great source of power which can also be used for the reduction of iron ores. Once gone, it cannot be replaced or reproduced. Moreover, the development and most extensive use of the four other sources of power cannot be achieved without metals, and, foremost, without iron and steel for the necessary appliances, machinery, and structures. Without coal, no iron and steel; without iron and steel in great masses, no great machinery for utilizing the sources of power. In view of this fact, already known as well as we can ever know it, the question how long steel and iron bridges will last becomes most important, because the time must come when they cannot be replaced. Will they last as long as stone bridges, of which, as mentioned before, we have some two thousand years old yet in use?

The answer can be given now with as much certainty as one thousand years hence.

A strong and well-designed iron or steel bridge, effectually protected against corrosion, will endure many centuries,—in fact, should endure forever.

But the qualifying conditions are important ones. By a strong



IRON ARCH BRIDGE OVER THE BALTIK CANAL AT LEVENSAN.
Carries a railroad and a wagon way; span 320 feet; completed 1894.



IRON ARCH BRIDGE OVER THE BALTIC CANAL AT GRUENENWALD.

Span 510 feet ; completed 1894.

and well designed structure is meant one in which every part is secure as shown by calculation against over-straining of the metal, within now-well known limits, from any loads or forces that may legitimately affect the structure.

The alleged crystallization and final brittleness of iron and steel, through long-continued use and vibration, is a fable, unworthy of scientific belief, because unsupported by germane facts. It originated from the frequent fracture of over-strained and abused metal, in which the proper limits of allowable stress were not observed. Iron so over-burdened will break down, vibration or no vibration, just as an over-burdened horse will break down. The familiar legend of the fiddler, who could if persevering enough, fiddle down a bridge, which is meant to be metaphorical of the destructive force of cumulative rhythmical oscillations, need cause no apprehension that a strong and properly designed metal bridge can ever suffer or break down under the regular step of a regiment marching to music. A metal bridge can be made just as safe in that respect as a stone bridge. With stresses in iron and steel not exceeding one-third to one-tenth of the breaking strength, the durability will surpass that of stone arch bridges, in which the pressures usually range from one-tenth to one-twentieth of the breaking strength of the stone, provided that the one other condition, protection against corrosion, be observed. This,

it must be admitted, has been so far found a difficult, if not impossible, condition.

Good stone requires no such protection. Well-built stone masonry will slowly deteriorate through ages, as the rock of mountains deteriorates, through the action of changing heat and frost, rain and wind.

But, while iron and steel resist temperature influences better than stone, they suffer more from the chemical action of water and air, and particularly from acidulous gases and moisture, for the exclusion of which from the iron surfaces no known paint gives prolonged protection.

That is to say, the durability of iron and steel structures will depend first upon the permanent scientific skill with which they are inspected and protected. Since the painting and constant care against corrosion constitute a permanent expense not required by stone arch bridges, the latter, notwithstanding their larger first cost, should always be favored in places where an economic advantage accrues from the saving in cost of maintenance.

What are the position and prospect of the United States regarding the commercial field of bridge-construction for other countries, is a question often asked. A few months ago J. Stephen Jeans, secretary



BRIDGE OVER THE RHINE AT DUISBURG-HOCHFELD.

Spans each 550 feet; completed 1896.



THE WASHINGTON BRIDGE OVER THE HARLEM RIVER, NEW YORK. 1886-1889. SPANS 510 FEET.



STEEL ARCH BRIDGE OVER THE NIAGARA RIVER.
Carries railroad and roadway, taking the place of the famous Niagara suspension bridge. Span 550 feet. Completed 1897.

to the British Iron and Steel Institute, gave, in a series of articles published in this magazine, facts and reasons for the supremacy of the United States in the manufacture of iron and steel. Briefly stated, they are based on the great abundance of cheap and excellent fuel and iron ore, and low freight rates by rail and water, in the United States.

The far-reaching consequences from these facts have become apparent only within the last few years. Along with the great reduction in the price of steel rails as the principal steel product there has been a corresponding decline in prices for structural and bridge work.

The best and strongest bridges built anywhere in the world are to be found on the best American railroads. It is on them that first grew up the practice of thorough, systematic inspection, minute specification, and an exactness of workmanship equal to that in locomotive work.

The American bridge-builders are better equipped than those of other countries to compete for the many large metallic bridges that will be needed in countries not having their own bridge-works, like Japan, China, South and Central America, Africa, Asia Minor, the East Indies, Australia, and the West Indian and Asiatic Archipelagoes. The answer, therefore, to the before-stated question is that, if systematic efforts, through well-organized agencies, are made for obtaining this trade, it will surely go in open competition to the United States, by reason of their superior manufacturing facilities, which permit construction at a low cost. It is an indisputable fact that no other country builds its metal bridges as cheaply, albeit of excellent workmanship, as the United States. The difference in price for completed work is frequently as great as forty per cent., in favor of American work.

But, in this connection, I wish to say that more attention will have to be given to the æsthetical side of construction. It cannot be denied that, in that regard, America is behind the standards of Europe. There the more important bridges, particularly in cities, are invariably designed with a view to their architectural appearance. Details of construction are subordinated to it. The American practice is regulated more from the standpoint of utility, of quick fabrication and speedy erection, not always with the happiest results architecturally. Although the United States has the largest number of steel and iron bridges, it has also the distinction of having the ugliest. There are certain indications, however, of an improvement in taste, and it is entirely within the possibilities of the near future that American engineers will be able, in foreign competitions, to furnish designs for bridges at once architecturally meritorious and economic of cost.

THE COMPARATIVE COST OF STEAM AND WATER POWER.

By William O. Webber.

RECENT investigations into the changes in costs of steam and water power for the last twenty-five years develop results so surprising that they cannot be comprehended by the general public sufficiently to enable them to intelligently weigh the economic results that tend to influence the general industrial situation at the present day. There has been a great deal of talk and a great deal of writing, in the last few years, regarding the diversion of trade from one country to another and from one section to another, the whole force of this discussion seeming to be concentrated on one idea,—that such changes and diversions are due, in the first place, to the wages paid and the class and skill of the workmen employed, and, in the second place, to improvements in the machinery used,—entirely ignoring what seems to the writer one of the most important items in the case,—namely, the cost of power,—both the first cost, and that of the transmission of this power into useful work.

Taking, for instance, the steam engine as a prime mover, and taking the figures from a number of able articles on this question by such writers as F. W. Dean, we find that twenty-seven years ago—say, in 1870—the most economical engines in use in the United States were the Corliss simple condensing engines, which were using from nineteen to twenty pounds of steam per h.-p. hour. This was a vast improvement over 1860, when the steam-consumption was nearly double that amount.

At the same time English mill engines had been largely improved; but the advent of the Corliss engine, both in America and Europe, was followed by a marked improvement in the economy of steam-consumption, and twenty pounds per h. p. was considered good work.

The English engineers were the first to introduce the compound engine in mill practice, but their example was soon followed in this country, and resulted in reducing the consumption of steam to sixteen pounds per h. p. per hour. This was followed by still further improvements, lowering the consumption to fourteen pounds. The thirteen-pound mark was soon reached by increasing the steam pressure and increasing the ratio of expansion between the high- and low-pressure cylinders. The English engineers then modified this mark

by the introduction of triple-expansion engines, following that by quadruple-expansion engines. While but few of these have been introduced as mill engines in America, a great many have been used as pumping engines, with a marked increase in steam economy. Recently there has been introduced a simple, cross-compound, condensing engine, with a ratio of volume between the high- and low-pressure cylinders of $4\frac{1}{2}$ to 1. This engine, with 160 pounds' initial pressure, has developed a h. p. on $11\frac{1}{2}$ pounds of steam per hour. To realize what this means in dollars and cents, we must go back a little. We find that, assuming our engines of 1870 to have been using 20 pounds of steam with a boiler evaporating 8 pounds of water per pound of coal used, the total cost of this plant, including engines, boilers, buildings, chimney, and all accessories, was about..... \$70.00

per i. h. p. Taking the figures of charges on such a plant as:

Interest	@6%
Depreciation	@4%
Repairs	@2%
Insurance	@1%

13% of the total cost of \$70.00..... \$9.10

and taking coal at $2\frac{1}{2}$ pounds per i. h. p. per hour at \$7.10

per ton, we have $\frac{2\frac{1}{2} \times 10 \times 308 \times \$7.10}{2240} = \dots\dots\dots \$24.40$

Attendance on boilers, three day men at \$1.50 per day, and

one night man at \$1.50, that is, $\frac{\$6.00 \times 308 \text{ das.}}{1000} = \dots \$1.85$

Attendance on engine, one engineer at \$3.00 per day, one as-

sistant at \$2.00 per day, that is, $\frac{\$5.00 \times 308 \text{ das.}}{1000} = \dots \$1.54$

Oil, waste, and supplies..... \$1.25

Making a total cost of..... \$38.14

per h. p. per hour on a 1,000-h. p. plant. But, to fully show the difference due to changes in the plant alone, we must use the figures just quoted on the basis of the present cost of coal per ton. Therefore, substituting the price of \$3.85 per ton for \$7.10, we reduce to \$26.99 the cost per annum, in 1870, of a steam h. p. for large units of 1,000 h. p.

Taking this as a fair statement of the cost of steam power using a plant of the best character available twenty-five years ago, but using coal at present prices, we are prepared to institute a comparison with what can be done at the present time with steam power.

According to Mr. Dean's paper, a similar plant can be installed to-day for..... \$57.00
 per i. h. p., with a compound engine using $12\frac{1}{2}$ pounds of steam and boilers evaporating 9 pounds of water and 1.4 pounds of coal per i. h. p. for total coal consumed.

Taking fixed charges.....	@ 5%
Average depreciation.....	@ $3\frac{1}{2}\%$
Repairs... ..	@ 2%
Insurance and taxes.....	@ 1%

Total..... $11\frac{1}{2}\%$,

and we have $11\frac{1}{2}\%$ of the total cost of \$57.00..... \$6.55

With coal-consumption of 1.4 pounds per i. h. p. per hour at

$$\text{\$3.85 per ton, we have } \frac{1.4 \times 10 \times 308 \times 3.85}{2244} = \dots 7.41$$

Attendance on boilers, two day men at \$1.50 per day, and

$$\text{one night man at \$1.50 per day, that is, } \frac{\$4.50 \times 308}{1000} = 1.39$$

Attendance on engine, one engineer at \$3.50 per day, and

$$\text{one assistant at \$2.00 per day, that is, } \frac{\$5.50 \times 308}{1000} = \dots 1.69$$

Oil, waste, and supplies..... .80

Making a total cost of..... \$17.84,

showing, in twenty-seven years, a saving in first cost of 18.6 per cent. and a saving in operation of 53 per cent. The actual returns from the two best plants known to the writer has further reduced these figures to \$12.00 per h. p. per year. What this means in actual economy may be shown as follows:

At the rate of \$27 per h. p. per annum, taking a mill or other manufacturing plant with a capital stock of \$1,000,000, and requiring about 2,000 h. p., this cost of power would represent 5.4 per cent. of the capital stock. The actual figures from a yarn mill in Massachusetts in 1889 gave the cost per i. h. p. per year as \$20.67, representing 4.13 per cent. of the capital stock. Taking our 1897 figures of \$17.84, the cost would represent 3.56 per cent. of the capital stock. Taking our last figures of \$12, the cost would represent 2.4 per cent. of the capital stock, or a saving of 3 per cent. on the capital stock over the plant of 1870.

This last figure does not seem so astounding when it is considered that the simple superheating of steam can reduce the steam-consumption from 12.5 pounds to 10 pounds per h. p. per hour; that a num-

ber of engines have been built in the last year or two, consuming only one pound of coal per i. h. p. per hour; that the introduction of mechanical stokers and other coal-handling machines has largely decreased the attendance on boilers; and that there has been a saving of 5 per cent. due to vertical engines, of 7 per cent. due to vertical internally-fired boilers, and of 2 per cent. due to improved grates.

The lowest actual figure known to the writer to-day is \$11.64 per h. p. per annum, the coal costing \$1.76 per ton. The plant consists of a vertical, cross-compound, condensing engine, built by the E. P. Allis Company, with high-pressure cylinder 32 inches in diameter and low-pressure cylinder 68 inches in diameter, both of 5-foot stroke and making 75 revolutions per minute. The cylinders have a ratio of volume of 1 to 4.5, and the working pressure is 150 pounds. The condenser is operated by an independent air-pump, driven by a small vertical Corliss engine. The load now carried averages 1,950 h. p., and, to give this, the required mean effective pressure of the high-pressure cylinder is about 55 pounds, and of the low-pressure cylinder about 12 pounds. The steam pressure is 155 pounds. The boilers are of the Heine water-tube pattern, having 216 square feet of grate surface and about 7,500 square feet of heating surface. An exhaust steam heater in the exhaust pipe of the low-pressure cylinder warms the water to about 120 degrees; it is then pumped through a Green Economizer, which carries the temperature to a point varying from 215 degrees to 250 degrees. Draft is produced by a chimney 175 feet in height.

The coal used is semi-bituminous, of a grade somewhat inferior to Cumberland or Pocahontas, and costs \$2.26 per gross ton, delivered in the yard, close to the boilers.

The following is a tabulated statement of the cost of power:

Fuel per h. p. per year of 3,070 hours	\$4.70
Labor.....	1.88
Supplies and repairs.....	.42
Total operating expenses.....	\$7.00
Interest at 5 per cent.....	\$2.05
Depreciation at 5 per cent.....	2.05
Taxes.....	.41
Insurance.....	.04

Fixed charges..... \$4.55

Total cost of power per year.....\$11.55

The fuel includes the fuel used in banking fires at night, and that required for the supply of five slashers.

If the steam used for other purposes than power were deducted, I believe it would reduce the fuel by 10 per cent., or 47 cents per h. p. per year, making the total \$11.08. The tons of fuel used per h. p. year is 2.08.

At \$11.08 per h. p. per annum the cost per power is 2.2 per cent. of the capital stock, and shows a saving of 3.2 per cent. over the plant of 1870.

This is certainly a very fair dividend to be obtained as a saving in cost of power alone, and one which should not be ignored in these times of close competition.

Besides this, there are the losses in transmission, which can be reduced greatly, and the increased production due to constant speeds, fully maintained, which can be effected by electrical means, resulting in another saving fully as large. These are facts, not fancies; they can be demonstrated by actual figures in the possession of the writer.

Another feature of this power problem is the extremely low cost per h. p. per year for water-power plants developed in late years and not encumbered by an octopus in the form of a land and water power company, which puts such a burden on the users of water power that they cannot compete with more favorable localities.

In a paper written by the writer's father, Col. Samuel Webber, in 1895, for the American Society of Mechanical Engineers, the cost of installation is placed at \$100 per h. p.; probably it has exceeded this very largely, owing to the changes involved in new wheels, etc.

At Augusta, Ga., the cost of construction was \$90.00 per h. p.; at Columbia, S. C., the cost was only \$72.00 per h. p. The cost of the Concord Water Power Company on the Merrimack river was \$63.72 for minimum of 3,300 h. p., and a cost of \$42.05 for average of 5,000 h. p. These are costs of dams and canals. To this should be added costs of pits and foundations and wheels, bringing up the cost for average flow, for whole plant, to \$57.75, and for minimum flow to \$78.88, per h. p.

Now, basing the calculations of cost on the minimum flow,

allowing 5% for interest,
 2½% for sinking funds,
 1½% for repairs, and
 1% for taxes, we have

10% total annual cost,

equal to \$7.89 per h. p.; and, adding 75c. per h. p. for oil and attendants, a total cost of \$8.64 per h. p.

The total cost at Columbia, S. C., is \$9.50 per h. p., and at Augusta, Ga., \$11.05 per h. p.

I have recently figured the actual cost of developing a small water power, and obtained the following results :

Dam complete.....	\$ 266.84	
Filling.....	60.00	
Carpenter work.....	150.00	
		\$476.84
Wing walls 270' × 9' × 3' @ \$3.25 cu. yd.....	810.00	
Digging and filling.....	162.00	
		\$972.00
Forebay, including rack, gates, etc.....		680.00
Race way 8' × 16' × 320' = 1517 yds. @ \$1.50 cu. yd.....		2275.50
Tail race 8' × 16' × 150' = 800 " " 1.50 ".....		1200.00
Tail race walls = 150 " " 4.00 ".....		600.00
Wheel pit = 231 " " 6.00 ".....		1386.00
Wheel pit excavating = 85 " " 1.50 ".....		128.00
Masonry, flash boards, and rack.....		380.00
Flume and forebay, 7'4" × 10'4" × 200'. Lumber 25000' @ \$11.00.....	275.00	
2" plank 8' × 8' timbers 4' apart. Bolts 3c. lb.....	75.00	
Labor on same.....	200.00	
		550.00
Second flume 20' long.....		60.00
Second tail-face 200' × 8' × 10' = 600 yds.....		900.00
		\$9608.34
2 35" wheels in horizontal case.....	\$2200.00	
2 draft tubes and flume and iron work.....	400.00	
		\$2600.00
1 27" wheel.....	950.00	
Flume, draft tubes, and iron work.....	200.00	
		1150.00
		\$13358.34
Cost of plant per horse-power, \$42.15.....		
Cost of plant, total, \$13,358.34 @ 6%.....		\$800.00
Depreciation on \$3750 @ 5% (wheels and iron work).....		187.50
Depreciation on \$1086 @ 10% (wood work).....		108.60
Repairs per annum.....		100.00
Insurance, \$4836 @ 1%.....		48.36
Taxes @ 2% on \$13,358.34.....		267.00
Attendance, oil, etc., per annum.....		200.00
		\$1711.46
Cost per annum, improvements alone.....		\$1711.46
Value of riparian rights, \$500.00.....		
Interest @ 6%.....		\$30.00
Taxes.....		10.00
Cost per annum, including land adjacent to pond.....		\$1751.46

The maximum total power of the three wheels is 510 h.p. and the minimum, 161 h.p., and the average is 315 h.p., the latter giving for the cost of the power \$5.42 per h.p. per annum, or including the land flowed and adjacent to the pond, \$5.56 per h.p. per annum.

THE UNDERGROUND RAILWAYS OF LONDON.

By Frederick E. Cooper.

WHEN, in course of time, the construction of railways connecting London with the principal towns of Great Britain could be no longer delayed, many considerations, principally public prejudice, necessitated their termination on the outskirts of the metropolis. Thus, on the north side of the Thames the termini of the London & Bristol (now the Great Western Railway), the London & Birmingham (afterwards merged into the London & North-Western Railway), and the London & Colchester (now the Great Eastern Railway) were originally located at Paddington, Chalk Farm, and Shoreditch respectively, each distant about three miles from Charing Cross. Similarly on the south side the London & Brighton Railway had a terminus jointly with the South Eastern Railway, the line to Dover, at London Bridge, and the London & Southampton Railway stopped short at Nine Elms, each being about two miles distant from the before-mentioned central point.

In these days of time-saving and fully-recognised importance of public convenience it is amusing to recall the arguments then put forward against the advance of railway facilities towards the business centres and residential districts of the metropolis. Royal commissioners gravely reported that they thought the advantages to the public of bringing railway stations further into the city had been exaggerated, because they found, on enquiry, that the average distance travelled by passengers who arrived at Euston was sixty-four miles, and concluded that the saving of a mile or two was of little importance.

It was not long, however, in the case of the London & Birmingham Railway, before it became sufficiently obvious that the out-of-the-way situation of their proposed London terminus would be a great inconvenience to their passengers and a great hindrance to their business. Therefore the extension of that line was taken in hand, and completed to Euston square in 1838. Some years afterwards the London & Southampton Railway was extended to Waterloo, but a longer interval elapsed before the extensions of other lines to Victoria, Charing Cross, and Liverpool street were carried out. The Great Western Railway has, in its intimate connection with the Metropolitan Railway, a practical extension of its system and a means



METROPOLITAN RAILWAY EXCAVATION; NOTTING HILL. 1869.

of distributing its traffic in the city and central portions of London.

The extension of the London & Birmingham Railway from Chalk Farm to Euston square, though short, is of special interest in connection with the subject of the present paper; for it was the first example of underground-railway construction, and in the details and difficulties encountered much useful experience was gained, by which subsequent undertakings profited.

From the commencement, at the crossing over Regent's canal, to Euston square, the length is $1\frac{1}{8}$ miles, of which 1,526 yards consist of bridges and covered ways and open cutting with retaining walls, the remainder being occupied by the station. The bridge over Regent's canal is of the bow-string type, 50 feet span, and has been much admired. It is of cast iron, with tension members formed of wrought-iron bars (two to each girder and $3\frac{1}{2}$ inches in diameter), the utility of which was, at the time, gravely doubted by some engineering authorities. The covered ways and bridges, having an aggregate length of 310 yards, are double, each 25 feet wide with a 4-foot pier between; in some instances the covering is a brick arch 2 feet 5 inches thick, elliptical in form, with a rise of 8 feet; but, where the rails are nearer the surfaces, crescent-shaped cast-iron girders are made use of, 2 feet deep at the centre



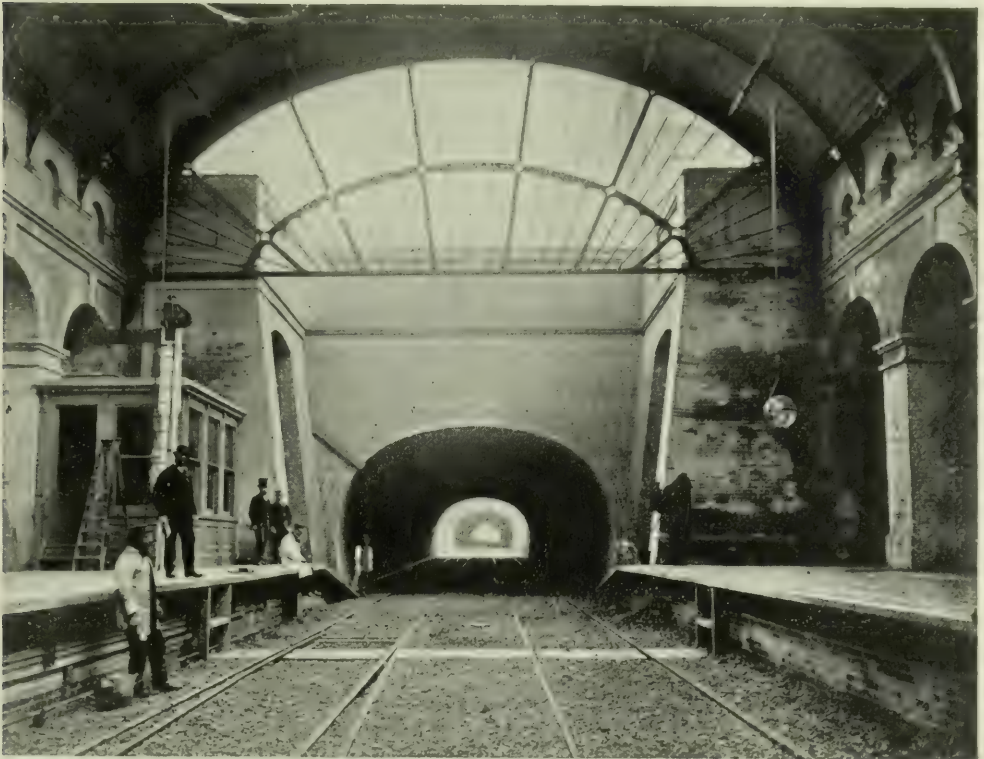
METROPOLITAN RAILWAY; WORKS AT PRAED STREET.

and 1 foot deep at the ends, with a rise of 2.6 feet and spaced 6 feet apart, jack arches 9 inches thick being turned between them. The retaining walls had a curved batter on the face, but, being somewhat light in section, the treacherous material behind them has for years given much trouble, for, though cast-iron struts 54 feet long were interposed between them, and their thickness was much increased, they have not proved stable, even when wrought-iron struts were substituted for those of cast iron.

The level of the rails at Euston station is no less than 54 feet below that at the canal; consequently the gradients are rather severe, a considerable portion being 1 in 64. When first constructed, owing principally to the opposition of the owner of the land traversed, the use of locomotives was prohibited on this extension, and the trains were hauled up the incline by rope-traction, the engines being situated near the canal bridge, while those for Euston were run down by gravity alone. In course of time, because of the noise of the pulleys on which the rope ran, and the smoke nuisance (more or less imaginary) of the locomotive, locomotives were made use of to haul the trains, in place of the rope. Two were generally attached to each train. That in front was detached on reaching the canal, and, running quickly ahead, was turned into a siding, while the train pursued

its course with undiminished speed. But for many years the incoming trains descended the incline under the control of hand-brakes alone, after the necessary impulse to start them had been given by a locomotive in the rear.

About the middle of the century public attention was most intensely directed to railway construction, chiefly on account of its probably lucrative character as an investment, but also, in the minds of far-seeing men, on account of its immense possibilities for public convenience. Naturally the metropolis became the field for numerous schemes designed to provide it with adequate railway facilities. With-



METROPOLITAN RAILWAY NEAR PRAED STREET.

out referring to many of these, which, of great interest in themselves, have since, in a modified form, been carried out, I shall describe here only that which may be deservedly considered the most complete example of urban railway construction,—namely, the Metropolitan, or, as it is popularly termed, the “Underground” Railway.

The origin and early development of this work were as follows. The New road, now divided into Marylebone, Euston, and Pentonville roads, the most northerly of the great east and west routes in London, being a fine broad thoroughfare, with the main buildings, as a rule, lying well back on each side, has been, from early days, the scene of attempts to improve locomotive facilities. Along this road,



METROPOLITAN RAILWAY, NOTTING HILL RETAINING WALLS.

sixty years ago, the steam carriages of Hancock and others, the prototypes of the auto-car, plied successfully, and it was only when physical obstacles to their progress were made use of, in compliance with ignorant prejudice, that they were withdrawn.

It is not surprising, therefore, that this road should be suggested as the course for a railway, which could be constructed beneath its surface with but little expense for property,—that most important item in the cost of urban railways. Parliamentary powers were sought and obtained, in 1853, for the construction of such a railway, extending from Paddington to Kings Cross. Having now obtained a footing, the promoters proceeded to develop and improve the scheme, and modifications were introduced, the principal feature being a connection with the Great Western Railway, then terminating at Bishop's Road, Paddington, and its practical extension to the very centre of the metropolis, where a convenient piece of land, going to the north of Holborn and west of Farringdon street, had lately, through the action of the city authorities, been cleared of its wretched dwellings and more miserable inhabitants, so well described by Dickens in "Oliver Twist." An act for the extensions, east and west of the authorised line, for the objects above described, was obtained in 1854, and, shortly after, branches to the Great Northern Railway, then

recently opened, were added to the scheme. After many difficulties, financial and other, the works of the modified line were commenced in 1860, and the line from Bishop's Road to Farringdon street was opened January 10, 1863.

The length of the line is $3\frac{3}{4}$ miles, 3 miles of which are beneath streets for the occupation of which no payment was made. About $\frac{1}{4}$ mile was constructed on cleared ground, the property of the City of London, for which a comparatively nominal sum was paid. The remainder is under land acquired under compulsory powers, and at that time covered generally by a poor class of dwellings. The types of construction adopted were brick-arched covered way, open cutting with retaining walls with and without struts between, and ordinary driven tunnel. The arch covered way, forming about sixty-five per cent. of the whole length, was made use of when the rails could be laid at about 20 feet below street level. The arch was elliptical in form, and 2 feet 5 inches thick at the crown. The radius of the centre part is 19 feet, and that of the haunches 9 feet 3 inches. The side walls at the foundation are 4 feet thick, and at the springing 2 feet 5 inches, where they are 28 feet 6 inches apart, that width being sufficient to permit of the passage of the Great Western Railway Stock, at that time built to a gauge of 7 feet $\frac{1}{2}$ inch. The



METROPOLITAN AND DISTRICT RAILWAYS, DOUBLE COVERED WAY, SOUTH KENSINGTON.

excavation, as a rule, was made to the full width of the structure, 33 feet 6 inches, the sides being kept in place by closely-placed poling boards supported by horizontal walings about 3 feet apart, strutted to the opposite, at intervals of about 7 feet, by whole timbers. The cost per yard was about £50. About half of the material excavated was clay, the remainder being gravel and sand.

Generally, during the progress of the work on the site of the roadway, the roadway was closed in sections about 200 yards in length, the traffic being diverted to the side streets, often for periods



METROPOLITAN AND DISTRICT RAILWAYS; DOUBLE COVERED WAY, KENSINGTON.

of as much as four months. This diversion and dislocation of the traffic was found to be an intolerable nuisance; consequently, in after times, under similar circumstances, the public authorities insisted on temporary roadways for at least a portion of the width of that affected. The cost of this was considerable, amounting sometimes to 5 shillings per square foot.

In its course the line traversed high ground at Clerkenwell, necessitating the driving of a tunnel 728 yards long, which was completed in eighteen months at an average cost of £70 per lineal yard.

Two of the stations at each end were constructed within retaining walls, with open iron and glass roofs; but those at Baker street,



DISTRICT RAILWAY ; COVERED-WAY GIRDERS, WESTMINSTER.

Portland road, and Gower street, being beneath the roadway, are brick-arched structures 45 feet wide. Air is admitted at the sides through openings lined with white glazed tiles. The platforms were 300 feet long and 12 feet wide, but were increased to 15 feet on the abolition of the broad gauge. The cost of such a station was about £18,000 in excess of that of the covered way for the same length.

In order to provide facility of access to the stations from the streets, and to diminish the cost of excavation, the railway was constructed at a level as near as possible to the surface. Consequently there was considerable interference with gas and water pipes and sewers. Where it was possible and convenient, the latter were diverted ; but in two instances, where the courses of the lateral valleys—that of the Tybourne and that of the Fleet—were crossed, costly structures had to be executed to carry them over the railway. The Fleet was crossed no less than three times, the conduits being cast-iron tubes of maximum dimensions of 10 feet in width and 10 feet in height, supported on cast-iron girders.

The traffic of this first length of line opened was a surprise to every one ; for two months after that date the number of passengers was at the rate of nearly three millions per mile per annum as compared with 7,361 on the Great Western Railway, the receipts per mile per annum being more than £600.



DISTRICT RAILWAY OPPOSITE SOMERSET HOUSE, 1869.

The year 1863 was marked by the extraordinary amount of attention devoted to the relief of the continually-increasing traffic in the streets of London.

A committee of the house of lords was appointed to consider the question, and they came to the conclusion that there were many and great objections to the concentration of the railway traffic by the construction of central joint stations, but that it "would be desirable to complete an inner circuit of railway that should abut upon, if it did not actually join, nearly all the principal railway termini in the metropolis, commencing with the extensions in an easterly and southerly direction of the Metropolitan Railway from Finsbury circus at the one end, and in a westerly and southerly direction from Paddington at the other, and connecting the extremities of those lines by a line on the north side of the Thames."

As an outcome of this recommendation the Metropolitan Railway Company applied in the ensuing session for powers to extend their existing line at each end, westward through Notting Hill to South Kensington and eastward by way of Aldgate to the Tower. Incorporation of an independent body was proposed for the purpose of completing the southern portion of the circuit, by way of the Thames Embankment, by the construction of the Metropolitan District Rail-

way. These proposals, after some modifications, and with the support of the local authorities, were sanctioned, the total length of the circle being a little more than 13 miles, and the number of stations being 27.

Among the many suggestions of the before-mentioned committee was one which appealed strongly to those using the public thoroughfares, being that, except where unavoidable, railways should not be carried along beneath existing streets where it was proposed to interfere with the surface, but that private property should be acquired for their construction. This was no doubt a very wise suggestion, as it put a stop to the very objectionable temporary closing of the streets and dislocation of the traffic using them; and, as the railways were thus diverted to private property, opportunities were afforded by which the ventilation of the line and stations, already found defective in the original line, could be much improved by breaking up the lengths of covered way by open cuttings. On the other hand, it was possible to recoup some of the cost of the land by erecting upon the covered ways, when not beneath streets or public property, buildings of a suitable character. To such an extent has this been done that there is now hardly a single spot on either line which, where the conditions permit, is not covered by buildings of some sort.



DISTRICT RAILWAY; CHATHAM PLACE.

The Inner Circle Railway was not completely joined up until late in 1884, the last portion constructed being that between Mansion House and Tower Hill, a distance of three quarters of a mile. The enormous value of the land traversed, and the costly works necessary to adequately maintain the traffic along, and to secure against injury the houses on each side of, Cannon street, beneath which the line is constructed for a length of about 300 yards, had for many years deterred the companies interested from venturing on the outlay, and it was



DISTRICT RAILWAY ; THAMES EMBANKMENT, 1869.

chiefly owing to the contribution of £800,000 by the authorities, on condition that certain new streets be made, that it was undertaken.

After 1863 construction along the remainder of the circle proceeded in a manner similar to that adopted for the original portion of the Metropolitan Railway ; but, as there was no necessity of providing for broad gauge stock, the width of the covered ways and the distance between the retaining walls in the open cuttings was reduced to 25 feet. For many reasons also it was frequently desirable to reduce the distance between rail-level and the surface of the streets above. In such cases cast-iron girders, generally 2 feet 6 inches deep, spaced 8 feet apart, with 14-inch jack arches between, formed the roof. The side walls were panelled and 5 feet 6 inches thick. The cost was in-



CONSTRUCTING WIDENING LINES UNDER EXISTING METROPOLITAN RAILWAY.
Farringdon Street, looking south.

creased about £12 per cubic yard. The stations, as a rule, were placed in open cuttings within retaining walls covered in with elliptical arched iron and glass roofs 50 feet 6 inches span. They have short lengths of open cutting at the ends, for ventilation. The platforms are 300 feet long and 15 feet wide, the extra cost varying from £14,000 to £22,000.

Since 1874 the permanent way, much modified at various times, has been of bull-headed steel rails, weighing 87 pounds per yard, in chairs of 47 and 39 pounds' weight, on sleepers 12 inches by 6 inches laid 2 feet 8 inches apart.

Much variation in the cost of the works per mile of the different portions of the Inner Circle is not to be wondered at, when the circumstances attending their construction are considered. The original Metropolitan Railway cost about £186,000 per mile, while the last-completed portion, from Mansion House to Aldgate, cost at least double that amount.

The capacity of the Inner Circle Railway is limited by the shortest interval between trains,—about $2\frac{1}{2}$ minutes,—and the maximum number of passengers in each train,—nominally 420, though on occasions those standing increase it 50 per cent. Under extreme cir-

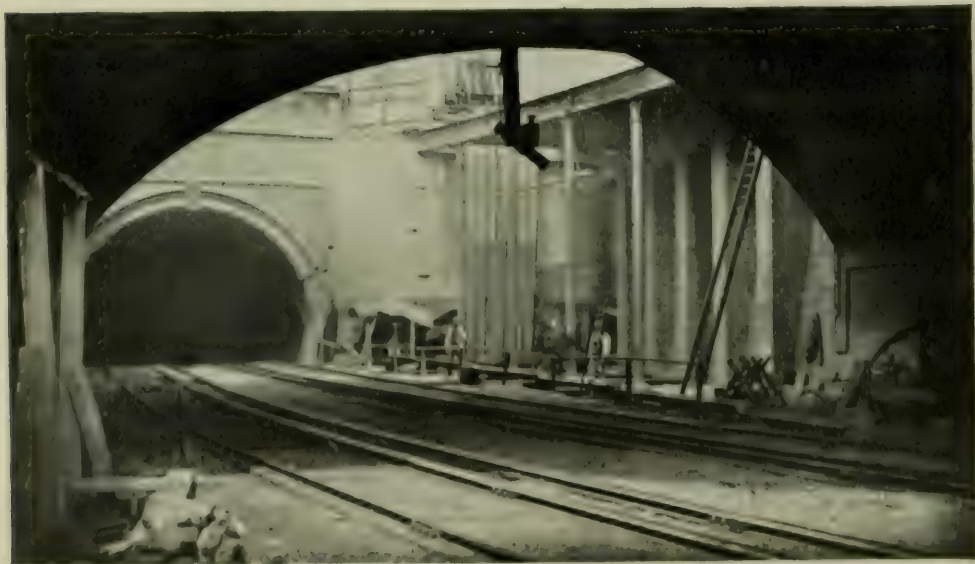


WIDENING LINES COMPLETED UNDER EXISTING METROPOLITAN RAILWAY.
Looking south.

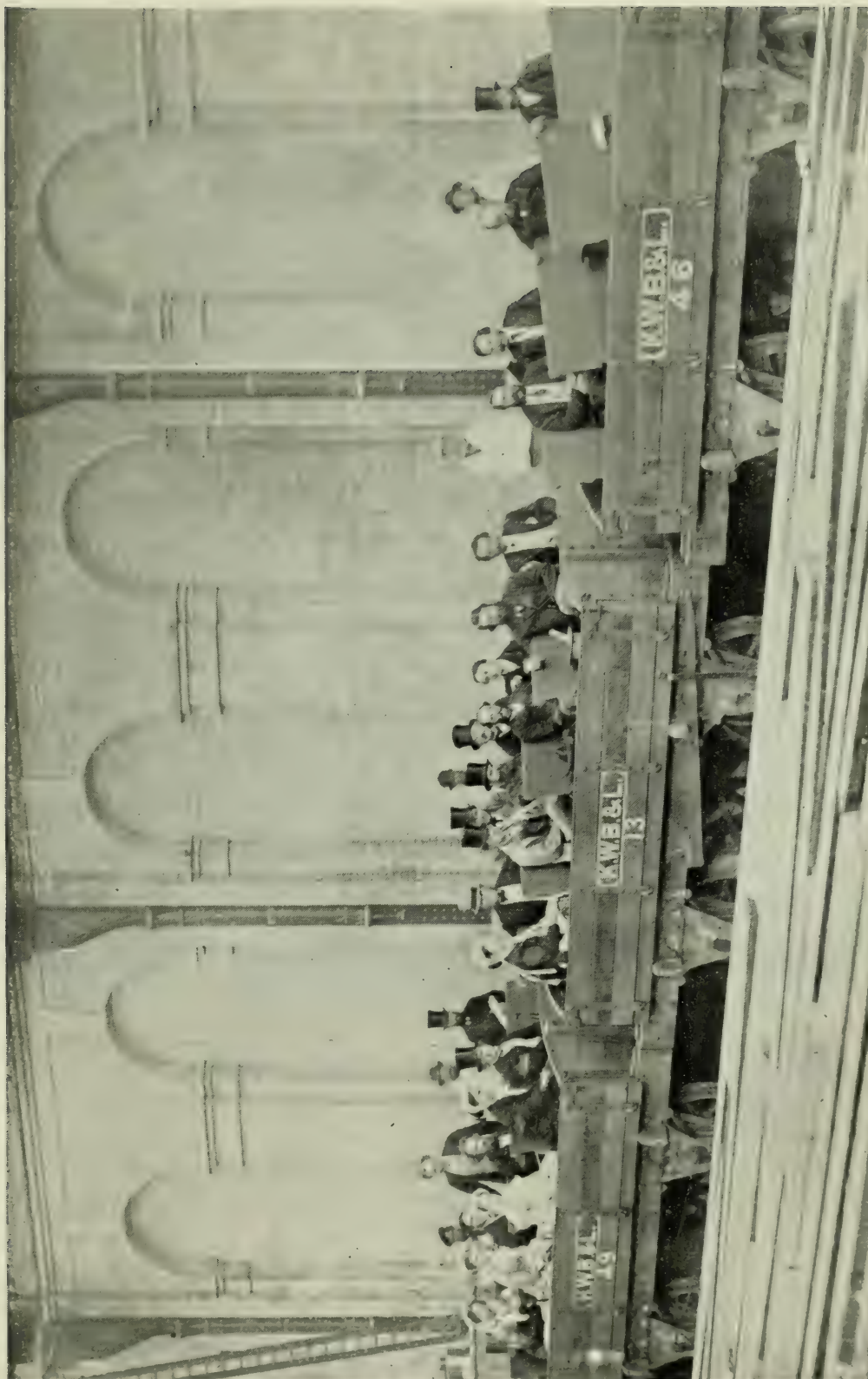
cumstances as many as 15,000 could be conveyed in each direction past a given point in an hour.

A complete circuit of the line is made in 70 minutes. Deducting a stop of 30 seconds at each of the 27 stations, the average speed is about 14 miles an hour.

As so large a portion of the original line was to be completely cov-



CONSTRUCTING WIDENING LINES UNDER EXISTING METROPOLITAN RAILWAY.
Looking north.



a b c d e f g h i j k l m
 METROPOLITAN AND DISTRICT RAILWAYS; PRIVATE INSPECTION, 1868.
 a. Mrs. Gladstone; b. Countess Percy; c. Alderman Gilpin; d. Viscountess de Vesci; e. Mr. Gladstone; f. Sir John Fowler, Chief Engineer; g. Lord Ronald Gower; h. Sir William Harcourt; i. Mr. Woolner, Sculptor; j. Hon. P. Stanhope; k. Duke of Sutherland; l. Mr. J. A. Walker, Contractor; m. F. E. Cooper, Resident Engineer.



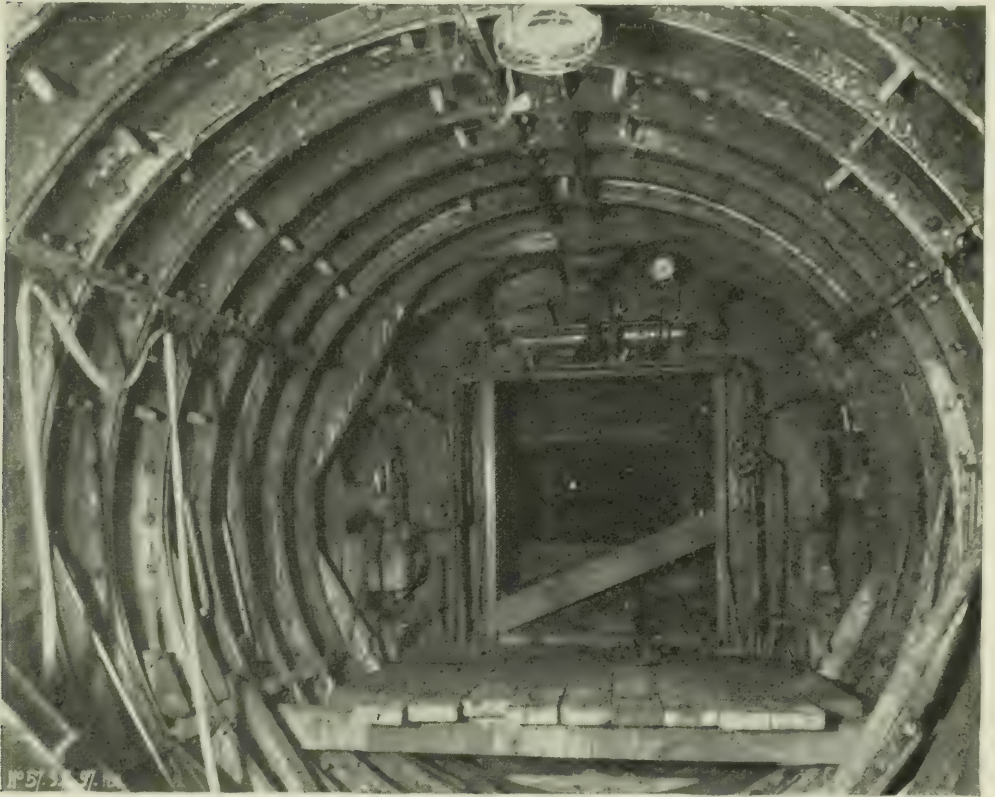
WIDENING LINES COMPLETED UNDER EXISTING METROPOLITAN RAILWAY.

Looking north.

ered in, no special provision being made for ventilation, there were certain essentials to be secured in designing the locomotive to be employed, the principal of these being the abolition of visible steam by condensation (no exhaust into the tunnels being permitted) and obviation of the necessity of burning fuel while traversing the line. To obtain the first of these conditions was not very difficult; the attempt to secure the second, by substitution of white-hot firebricks for fuel as a source of heat in the firebox, was abandoned without a trial. A locomotive, however, was constructed, at a cost £4,518, which had a small fire box for fuel and a large mass of firebrick stowed away in the barrel of the boiler, the idea being to work it as an ordinary locomotive with full blast on the open portions of the line, burning an excess of fuel to heat up the firebricks, and, on reaching the covered way, to closely seal the fires with dampers, preventing the escape of fumes. The heat stored up in the firebricks was to keep up the steam. But this locomotive was a failure. After several trials, the locomotives at present in use were designed. These weigh about 43 tons, with 30 tons on 4 wheels available for traction. The fuel first used was a special kind of coke, almost free from sulphur, but expensive. Notwithstanding all precautions, complaints were constantly being made of the impurity of the atmosphere in the tunnels.

Afterwards Welsh smokeless coal was substituted for the coke, on the score of economy. Owing to this, together with the increasing traffic, the nuisance has now reached such a point as to become almost insupportable, and both the Metropolitan and the District Companies are seriously contemplating the use of electricity as the motive power.

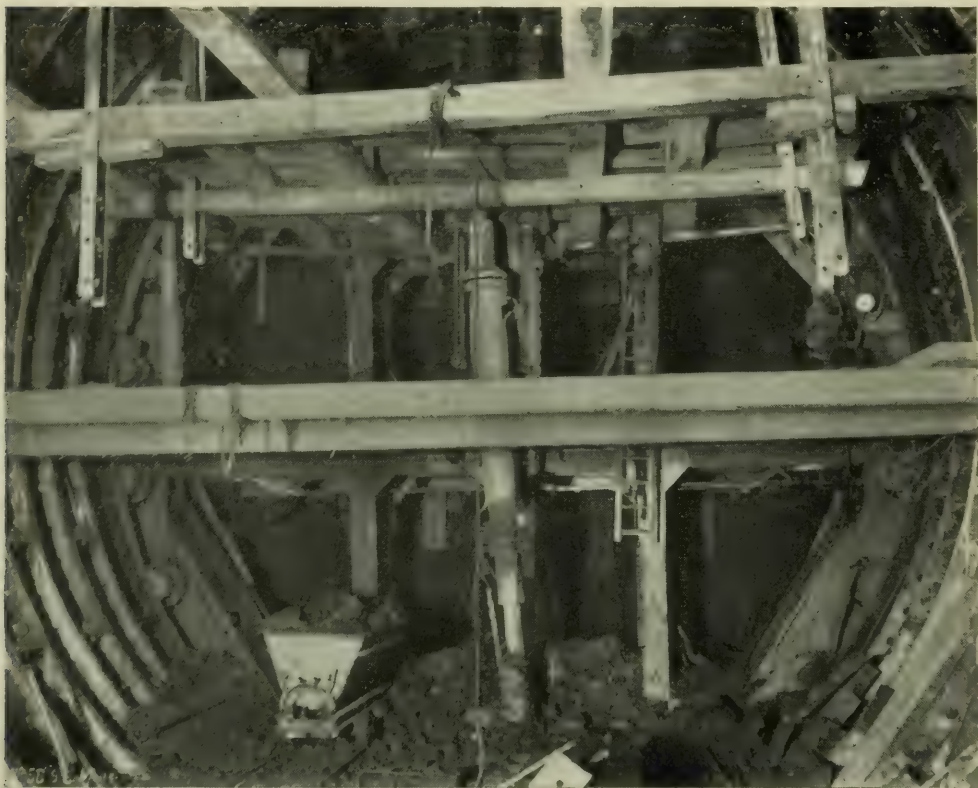
As may be gathered from the foregoing account of the first form in which underground railways were constructed in London, the difficulties to be surmounted in their development were found to be so great that for some years no proposals were entertained. Thorough-



CENTRAL LONDON RAILWAY ; 11 FT. 6 IN. TUNNEL AND SHIELD.

fares could no longer be made use of, even if the traffic using them could be maintained uninterruptedly. If constructed through private property, the enormous cost of its acquisition made it almost impossible to hope for an adequate return to the investor. In the case of an authorised line between Euston and Charing Cross, although a substantial guarantee was given by the companies interested, the public would not come forward with the cash. Furthermore, on account of the use of steam locomotives and the consequent difficulties of ventilation, the roads became very unpopular.

In the meantime the ever-increasing traffic in the streets of the metropolis, brought about both by the rapid extension in all direc-



CENTRAL LONDON RAILWAY ; 21 FOOT TUNNEL AND SHIELD.

tions of the residential districts, as well as by the great improvement in the facilities for travel afforded by the omnibus companies, the passengers by which have increased about four fold in the last thirty years, called urgently for fresh means of relief from congestion.

This has been attempted with encouraging success by the construction of deep-level tubular railways, constructed, as a rule, beneath main thoroughfares without interference with their surface or with the houses at the sides. These being worked by electricity, the difficulties attending efficient ventilation have been easily disposed of.

The pioneer in this system of construction and working was the City and South London Railway, which, authorised in 1884, was completed and opened at the end of 1890.

This railway is 3 miles 1 furlong in length. Commencing at King William street, near the Monument, it passes under Arthur street West and Swan lane to the river Thames, beneath which it is carried at a maximum depth of 73 feet below high water, the minimum distance between the bed of the river and the top of the tunnel being 20 feet. The railway then, for a distance of 60 yards, traverses Hibernia Wharf and Chambers,—the only private property interfered with,—and thence its course is beneath public thoroughfares *via* High street Borough, Newington Butts, and Causeway, to Stockwell.

For its construction the subway system, as it is called, was adopted, the practicability of which was proved by the formation of the Tower Subway 8 feet in diameter and 1,350 feet long, beneath the Thames, in 1869.

The essential features of this system may be briefly summarised as follows. The work is executed as a driven tunnel,—that is, without interference with the surface, and at such a depth as to be clear of all pipes, sewers, and other existing underground structures, a separate tunnel being formed for each line of way. The tunnels are circular in cross-section and small in size,—of dimensions just sufficient to permit the safe passage of the rolling stock. They are 10 feet 6 inches and 10 feet 2 inches in internal diameter. They are lined with cast-iron plates of such size and weight as to be conveniently handled, and the work is executed within a cylindrical shield, formed of thin steel plates, which sustains the soil while the plates forming the tunnel are put together, one ring at a time, within it. On the completion of this operation, as the excavation in front progresses, the shield is thrust forward by means of hydraulic jacks, uncovering the last ring of plates, and providing, in advance of that, room for the next ring to be put together.

As the forward movement of the shield leaves a cavity round the ring somewhat exceeding the thickness of the shield,—say, about 2 inches,—this might become, if unfilled, a cause of settlement in the soil above, resulting in deformation of the tunnel and damage to buildings in the vicinity. A simple and effectual apparatus has been devised by which liquid lime, by means of air pressure of 60 pounds, is forced into such cavities, completely filling them.

This system, in comparison with the covered ways on the earlier railways, shows the following essential differences. First, iron plates are substituted for brick linings, saving an appreciable quantity of excavation; secondly, instead of supporting the soil during the construction of the work by a costly system of timbering, the putting in of which is a tedious operation, and much of which is buried and lost, a movable shield is adopted, available for the whole of the section carried out by its aid; thirdly, the work can be executed in short lengths, generally 20 inches, which, together with the filling-in of cavities as described, prevents all movement of the soil, either by settlement, or exposure to the air for a long period. On the original lines, in many instances, movements of the soil did more or less damage to buildings in the neighbourhood.

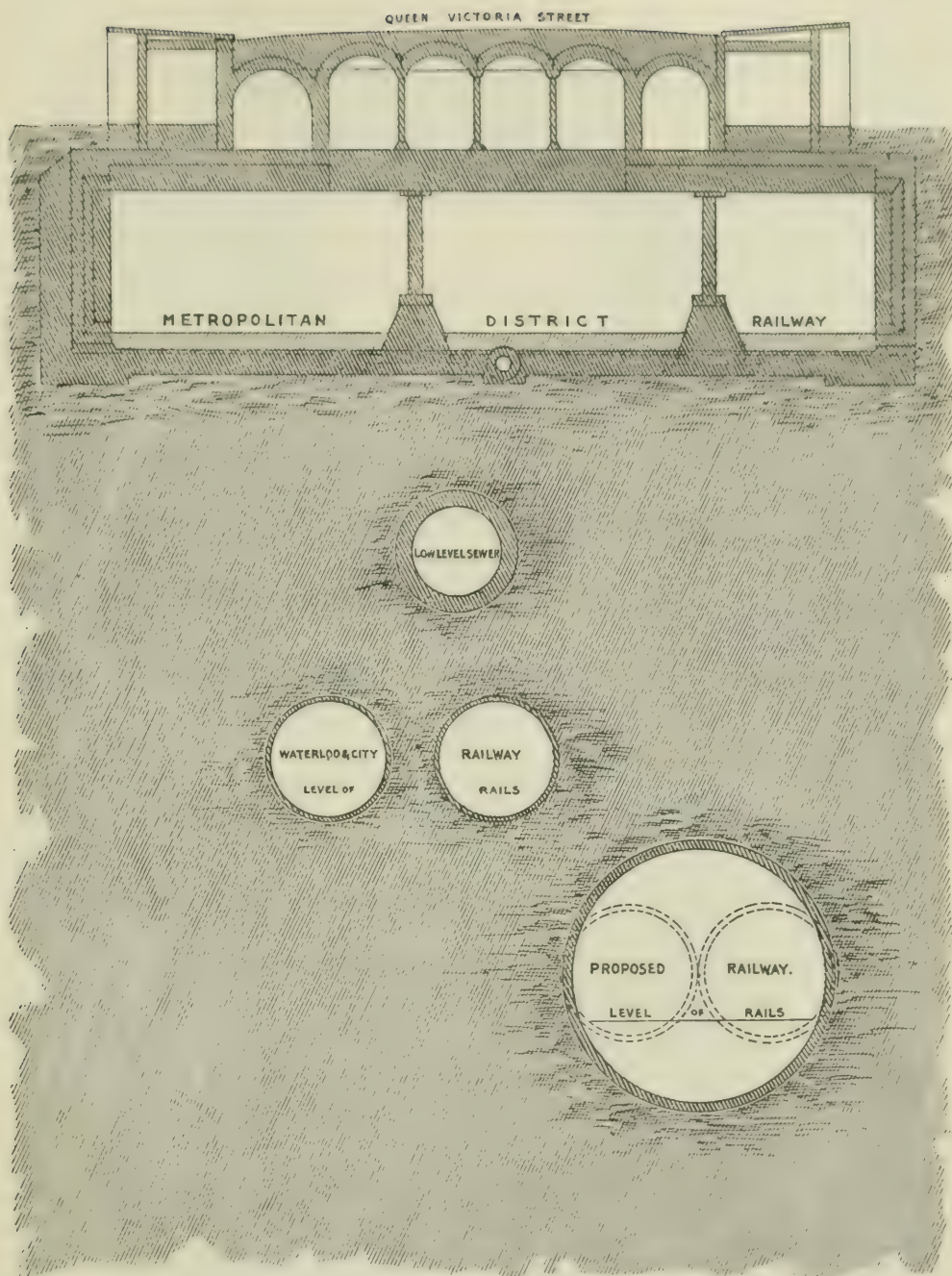
Beneath London the greater portion of the subsoil is London clay, and, though near the river, it is often overlaid with gravel, generally not of great thickness—rarely exceeding 20 feet. This clay is ex-

ceedingly suitable for the execution of tunnels on this system; it is perfectly dry and homogeneous (except when nodules of septaria are met with), and, if exposed only a short time, it is very stable; on the other hand, it is exceedingly hard and tough, and thus difficult to get. So great are the advantages for working which this material affords that, wherever possible, the tunnels constructed on this system have been kept sufficiently low down to be wholly within it; consequently the distance between the platforms and the surface of the streets is often considerable, varying on this line between 67 feet, at King William street, and 43 feet, at Stockwell. On a portion of the Clapham road a depression in the clay, filled with gravel charged with water under a head of 35 feet, necessitated the construction of about 200 yards of the tunnel under compressed air. About 50 yards near the city terminus was similarly dealt with,—of course, at greatly-increased cost. The enlargements at the stations, six in number, were constructed in brickwork, the excavations being timbered in the manner usual in ordinary tunnels. At the intermediate stations they are 200 feet long, 20 feet wide, and 16 feet high, each line having its separate tunnel with a platform 10 feet wide. At the terminal stations they are 26 feet wide and 20 feet high, and of greater length. Passages constructed in brickwork conduct the traffic to the stair-cases and lifts. The latter are of great utility, and, when introduced, were a novel substitute for the stairs. Notwithstanding the many objections urged against the use of lifts, their constant use on this line, and their almost universal adoption in lofty buildings all over the world, prove these objections to be ridiculous. Certainly without them deep-tunnel railways would fail to attract or deal with the amount of traffic necessary to ensure success.

The lift cages work in shafts 25 feet in diameter, lined partly with iron plates and partly with brickwork. They are nearly semi-circular in plan, and there are two in each shaft. They conveniently accommodate fifty to sixty passengers, who enter and leave at each end without confusion.

In the act authorizing the construction of the City South London Railway the use of steam locomotives was prohibited, the original intention being to use an endless-cable system of rope haulage; but so satisfactory had been the progress made with electrical traction during the time occupied by the construction of the line that that motive power was adopted, with very successful results.

The trains generally consist of three carriages of the tram-car pattern, carrying 100 passengers, and are of a total weight of 40 tons. The locomotives, weighing $10\frac{1}{2}$ tons, have two axles, with a motor on each, driving direct without gearing. The electric current at 500



SECTION OF QUEEN VICTORIA STREET.
Showing existing and proposed structures.

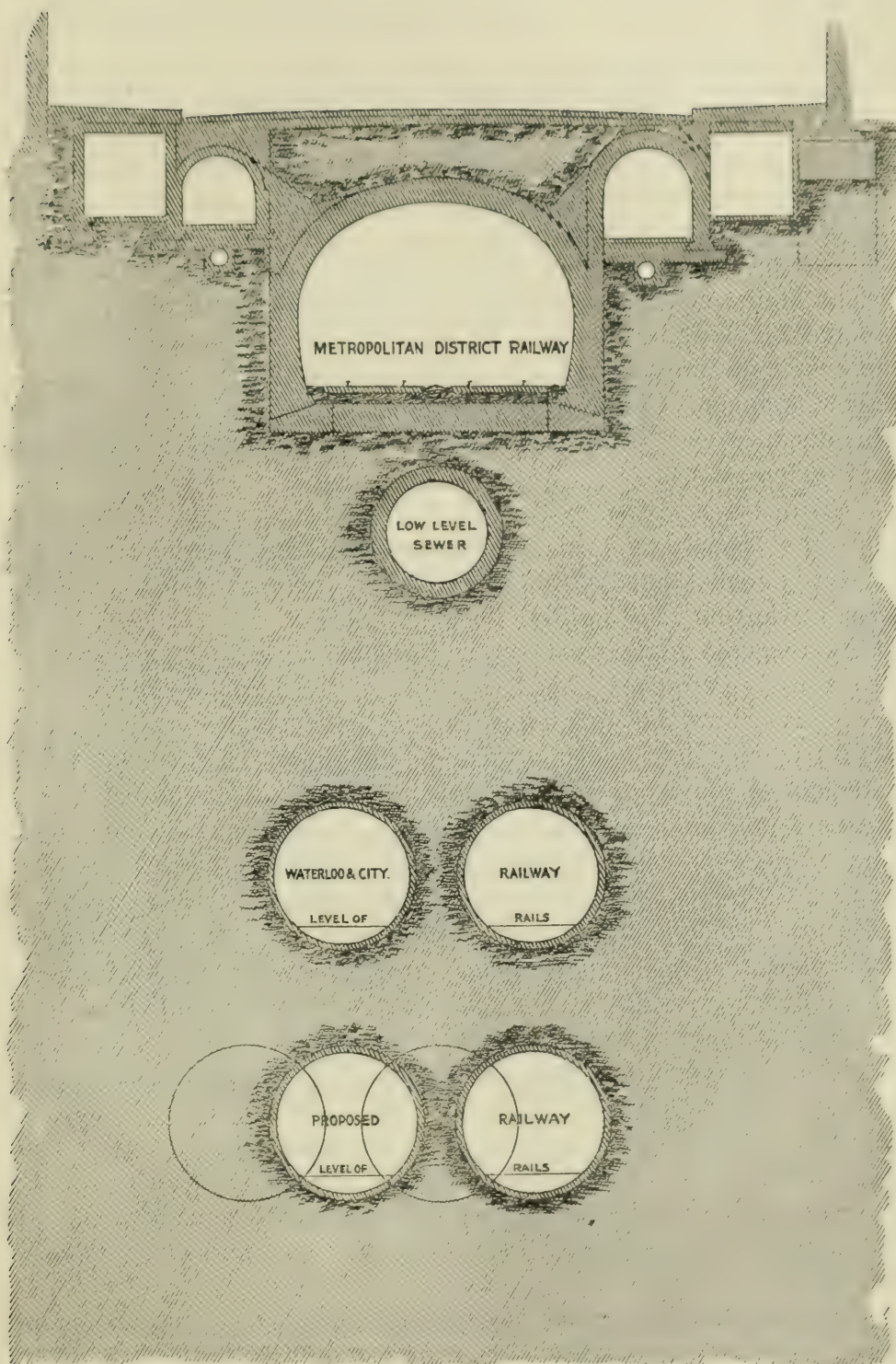
volts is delivered to the conductor, which is a steel channel weighing $10\frac{1}{2}$ pounds per yard. There are three collectors on each locomotive. The return circuit is through the rails. The average speed, including stops, is $11\frac{1}{2}$ miles per hour, and between stations $13\frac{1}{2}$ miles, with a maximum of 25 miles per hour, when 100 h. p. is developed, the electrical efficiency of the locomotive being 70 per cent.

During the construction of the City South London Railway, and shortly before its completion, powers were sought for the construction of a line, appropriately named Central London Railway, on the deep-level subway system, to be electrically worked, traversing the metropolis from west to east. Commencing in the Bayswater road at Queens road, it was to be carried along, but far beneath that road and *via* Oxford street, Holborn, and Cheapside, to a station near the Bank. As this line of traffic is probably the most densely crowded and congested in the world, it was rightly considered a most suitable course for a railway of this description. After a hard fight before committee, the bill was rejected. This result was due, no doubt, in some measure, to the fact that the method of working proposed had not, at that time, been proved a success; in fact, the Metropolitan Railway Company, one of the chief opponents, adduced evidence to prove that electric traction had been tried, at a cost of £20,000, on the Manhattan Railway of New York, and found a complete failure, the loss of power being no less than 85 per cent., leaving the efficiency but 15 per cent.!

In the following year, 1891, the scheme, so modified as to place the western terminus at Shepherds Bush, was again brought before parliament, this time with a successful result, partly owing, no doubt, to the satisfactory working of the City South London Railway, which had been open for some months, and which completely disposed of the allegations of the principal opponent at the preceding session.

The Central London Railway, including the extension to Liverpool street, authorised in 1892, is a little more than 6 miles in length, and there are fourteen stations, the greatest and least distance between stations being 58 and 31 chains respectively.

Some time elapsed before the financial arrangements were satisfactorily concluded, and not until 1896 did construction begin, since which time it has made satisfactory progress. The method of construction is similar to that described in the case of the City South London Railway tunnels, but the Central London tunnels are of larger dimensions, being 11 feet 6 inches in internal diameter. The station enlargements are also circular, 21 feet in diameter, sufficient for a platform 32 feet long and 11 feet wide, and lined with iron plates. West of Marble Arch there is but one lift shaft, 30 feet in



SECTION OF QUEEN VICTORIA STREET.
Showing existing and proposed structures.

diameter at each station. At each intermediate station on the remainder of the line there are two lift shafts, 23 feet in diameter, and at the Bank there are five, of a diameter of 20 feet. As a rule, there is at each station one stairway shaft, 18 feet in diameter, containing separate staircases for the ascending and descending passengers.

Westward of Farringdon street the railway tunnels and station enlargements are practically complete, and on the remainder of the line good progress has been made.

With the exception of a short length on the branch rising up to surface at the generating station at Shepherds Bush, the line is constructed below the surface of the London clay; in fact, there is in one case a statutory obligation to have a minimum of 20 feet cover. Near Tottenham Court road the lower portion of the tunnel for some distance is laid in the Reading beds,—a formation underlying the London clay.

The distances between the rail level and the surface of the road are least at Shepherds Bush and Westbourne Stations, where they are 54 feet 3 inches and 55 feet respectively, the maximum, 100 feet, being at Notting Hill Station.

As the cost of the work varies so much, according to the price of materials and labor, local conditions, and other disturbing elements, it cannot be detailed with sufficient accuracy to serve any useful purpose; but a general idea may be formed from the following statement of the labor and materials per lineal yard required in the 11-foot-6-inch and 21-foot tunnels and in the 23-foot shafts: cast iron, 2 tons $17\frac{1}{4}$ cwt., 8 tons $5\frac{1}{4}$ cwt., and 6 tons 13 cwt.; bolts, 2 cwt., $6\frac{1}{4}$ cwt., and $2\frac{1}{2}$ cwt.; excavation, 14 cubic yards, 45 cubic yards, and 50 cubic yards, respectively. To accommodate the traffic expected, which must be very great to ensure adequate returns for the heavy expenditure, adequate provision is being made.

The trains, 105 tons in weight, will consist each of seven carriages, accommodating 336 passengers. The electric locomotives will be very powerful, weighing 48 tons, upon 4 axles with a motor on each. Allowing for a stop of 20 seconds at each station, the speed will average 14 miles an hour, and the whole distance will be traversed in 25 minutes,—a great saving in time as compared with the existing omnibus journey of $1\frac{1}{4}$ hours. As a maximum, twenty-four trains per hour will be run in each direction.

Power will be generated at Shepherds Bush, and the current, at 5,000 volts, will be distributed at various points along the line, where it will be transformed down to 500 volts before being conducted to the locomotives.

The Waterloo City Railway, now rapidly approaching completion,

is practically an extension of the London & South Western Railway from Waterloo to the Bank, the length being about $1\frac{1}{2}$ miles, of which 1,000 feet are beneath the Thames.

Its construction is similar to that of the Central London Railway, but the tunnels are 12 feet in diameter, and access to the surface at each terminus is afforded by inclined footways in place of lifts.

Along Queen Victoria street the tunnels have been driven not only beneath the existing structure of the Metropolitan District Railway, but also beneath the low level sewer, a brick tunnel 8 feet 6 inches in diameter, the minimum distances from rail-level to rail-level of the former and to the invert of the latter being about 48 feet and 20 feet respectively.

Among the many examples of this type of construction which have been authorised by parliament the boldest and most unique is probably the proposed doubling of the Metropolitan District Railway by constructing beneath it a tubular railway from Earls Court to the Mansion House, a distance of 5 miles.

The tunnels are to be 12 feet 6 inches in diameter, and the rails are to be laid at depths varying from 18 feet 6 inches to 75 feet below the rails on the present line.

In traversing Queen Victoria street the top of the tunnels will, for a distance of 1,000 feet, be 8 feet beneath the lower portions of the tunnels constructed here by the Waterloo & City Railway.

There will be only two stations on this line, to be constructed beneath the existing Victoria and Mansion House Station, and access to the present platforms will be afforded by lifts and staircases.

The total number of journeys made during 1897 on the system of the Metropolitan Railway was 95,000,000, and on that of the District Railway 45,000,000, of which 43,000,000 and 22,000,000, respectively, pertain to the urban or underground portions of these systems. On the City & South London Railway the journeys in 1897 were about 7,000,000, making a grand total for the year, on the underground systems of London, of approximately 72,000,000.

SOME COMPARATIVE POINTS OF INTERNATIONAL PATENT LAW.

By J. Sinclair Fairfax.

THE oldest law of patents in the world is the British, James I, by the celebrated Statute of Monopolies of 1623-4, having abolished all monopolies then affecting the industrial welfare of the people, except patents for inventions.* These were limited to a period of fourteen years, and were granted for the purpose of establishing new manufactures within the realm, whereas pre-existing monopolies controlled the sale or manufacture of some of the most important articles of common use, such as coal, oil, salt, vinegar, glass, tin, lead, and iron. The grant for the monopoly of an invention was by open writs or letters, called "Letters Patent," so named to distinguish them from the closed letters of the sovereign, which are sealed on the outside; but other "Letters Patent" than those for inventions, such as are given for distinctions and appointments, continue to be granted by the crown to the present day.

The antiquity and form of British patent law naturally influenced other countries when drawing up similar laws, such changes as were made arising from the form of government, local requirements, and general experience gained in the working of the older law.† In the United Kingdom the original term of fourteen years still remains, and this is the case in India and most of the British colonies. In Canada it is now eighteen years, although formerly it was fifteen. In Belgium, Spain, Mexico, and Chili it is twenty years as a maximum, with some discrimination against patents of importation. Until the act of 1861 the United States term was fourteen years, with a privilege of extension; but subsequently it became seventeen years without such privilege. If the British patentee of a meritorious invention can satisfy the Judicial Committee of the Privy Council that he has not been adequately rewarded, despite his exertions, her Majesty in council may grant a further term of fourteen years, or any less term that its merits may suggest; but such extensions are seldom granted, and rarely exceed seven years. The majority of European countries

* For an excellent commentary on the Statute of Monopolies, and a *fac-simile* reproduction of the King's Book of Bounty (1610), on which it was founded, see "Monopolies by Patents," by J. W. Gordon, London. Stevens & Sons, Ltd., 1897.

† The first law of patents in France was established in 1791, by the *Assemblée Nationale* under the First Republic.

grant fifteen years as the maximum term, with conditions for the payment of annual taxes and working of the invention in the country within a limited period.

Separate patents were formerly required for England, Scotland, and Ireland, but now the British patent covers the three countries, and extends to the Isle of Man. From time to time changes have been made in the law, the most important of late years being the acts of 1852 and 1883. By the former the applicant for a patent had the option of proceeding with a provisional specification, which did not require drawings, claims, or a minute description of the invention, the latter being explained in general terms only. If the applicant proceeded, he was required to file a complete specification within six months from the date of his provisional, giving a detailed description of the means for carrying out the invention, and receiving in due course the Letters Patent bearing the great seal. This option of proceeding with a provisional specification is continued under the present law of 1883, with, however, an extension of the term from six to nine months, the patent subsequently obtained dating from the date of application.*

Many American inventors, and a few English ones, apply for the British patent with a complete specification, which, in the former case, is usually a copy of the United States specification as passed for issue, after an examination for novelty. This is a good plan, but the application, in most cases, should be filed in England not later than the date of issue of the United States patent, to avoid any question of prior publication, which would invalidate the patent. One objection, however, to applying with a provisional is that no action can be brought for infringement until the complete specification has been filed and accepted, it being obvious that the public are ignorant of the monopoly desired by the inventor until after he has formulated and published his claims. Nevertheless, the practice of applying with a provisional is popular in Great Britain, as the date of filing the application (if not affected by the international convention) fixes the date of a patent subsequently granted thereon, thus safeguarding the inventor's rights while he is making experiments or applying for foreign patents before he discloses the exact details of the improvements. Otherwise an inventor might unintentionally publish his invention (thus invalidating the subsequent patent) during the experimental stage, either directly by his own act in publicly showing the invention, or by disclosure on the part of a workman employed to

*“ Patents, Designs, and Trade Marks Act, 1883.” This is the principal act, but it has been amended in certain particulars by acts bearing the same title, passed in 1885, 1886, and 1888.

put it into a commercial form; but this danger does not occur in filing a complete application in the first instance, with claims and drawings, in which case, presumably, the invention has been fully thought out and presented in its finished condition. Owing to the two years provision of the United States law,* the danger of disclosing an invention, previous to applying for a patent in England, is not sufficiently appreciated by American inventors, many of them making their application some time after the issue of their patent from Washington.

Another danger is incurred by American inventors in not appreciating the different meanings applied to the term "first inventor" on opposite sides of the Atlantic. With one exception, it means in the United States the actual person who first reduced the idea constituting an invention to a practical form.† Some other person may have independently arrived at the same result, and even obtained a patent for the identical invention, yet the original inventor may obtain a patent subsequently which will override the prior one.‡ In other words, the actual inventor is not required to be the first applicant at the Washington patent office, whereas the first applicant at the London patent office is deemed the first inventor unless the case comes under the International Convention for the Protection of Industrial Property, or fraud is shown. Furthermore, in England, the "first inventor" may not have taken any part in making the invention, as an applicant who first introduces a foreign invention is deemed in law to be the true and "first inventor." The exception above referred to in United States practice is that, if an invention has been made in a foreign country, but not patented anywhere, or described in a book, the American inventor may subsequently obtain a valid patent for the same invention.**

The form of the British application is consistent with monarchical government and the origin of patent law, being by petition.†† The

* "Rules of Practice in the United States Patent Office," December, 1897. Rule 24, "Revised Statutes" of the United States, section 4,886.

† "No doctrine is better settled than that the subsequent inventor who perfects his invention and adapts it to use while one prior to conceive is unreasonably delaying is, in contemplation of law, the original and first inventor, and is entitled to a patent for the invention," *Lay v Wiard, United States Official Gazette*, IX, p. 349.

‡ "The right of a prior applicant will not be prejudiced by reason of a patent being issued inadvertently to a subsequent applicant, and the burden of proof rests upon the latter in trial for interference," *Gordon v. Withington, Off. Gaz.* IX, p. 1069.

** "Rules of Practice," 27; *Rev. Stat.*, sec. 4,923.

†† "And whereas the said inventor hath humbly prayed that we would be graciously pleased to grant unto him (hereinafter together with his executors, administrators, and assigns, or any of them, referred to as the said patentee) our Royal Letters Patent for the sole use and advantage of his said invention." *Form of Patent, Pat. Des. and Trade Marks Act*, 1883

applicant supplicates the crown for a monopoly according to the provisions of statute law, and, if a patent is granted, it is under conditions which have come down from James I, and are still claimed as crown prerogatives. But, influenced apparently by the British example, without its reason or consistency, the United States application is also in the form of a petition, addressed to the commissioner of patents*. The power to establish a patent law came from the people in this instance, and was delegated to the general government by the several States when they formed the Union; therefore the executive officer should simply be requested (and not petitioned, as for an act of grace) to examine the alleged invention according to law, and to issue a patent thereon if no anticipation be found. Nor is the petition required with the application the only one, inasmuch as a petition is also addressed to the commissioner of patents under Rule 145, when the examiner's decision on certain points is questioned. It seems more logical to put these matters of procedure upon the basis of a legal right, rather than apparently on the commissioner's favour.

The title is of much more importance in the British Islands than in the United States, the officials in the latter country altering it within certain limits to suit their forms of indexes and classification of subject-matter. The Mother Country, however, insists that the title shall correctly indicate the subject-matter of the invention, and, even if a title is accepted by the patent office, a British court of law may declare a patent invalid by reason of a defective title, as the public might otherwise be purposely misled by an incorrect or ambiguous title. It requires, therefore, careful consideration, after the nature of the invention has been fully described and understood. The title should be sufficiently comprehensive to embrace the full scope of the invention without going beyond it, and yet not too circumscribed, as some patents have been declared invalid for having titles too wide, and others for having titles too narrow. The title should be explicit, but should not disclose the invention, as such disclosure would amount, after the making of the application, to publication of the invention, and enable others to profit by the disclosure in completing prior applications, or in obtaining patents in other countries. The whole object of the title is to give a sufficient indication of the invention to any one interested in its subject, and therefore it must not mislead the public.

The subject-matter for which a patent may be granted is defined and limited in Great Britain by the sixth section of the statute of monopolies, which reads as follows :

* " Rules of Practice," 33; Rev. Stat., sec. 8,488.

Provided alsoe that any declaracion before mencioned shall not extend to any letters patents and graunts of privilege for the tearme of fowerteene yeares or under, hereafter to be made of the sole working or makeinge of any manner of new manufactures within this Realme, to the true and first inventor and inventors of such manufactures, which others at the tyme of makinge such letters patents and graunts shall not use, soe as alsoe they be not contrary to the lawe nor mischevous to the State, by raisinge prices of commodities at home, or hurt of trade or generallie inconvenient; the said fourteene yeares to be from the date of the first letters patents or grant of such priviledge hereafter to be made, but that the same shall be of such force as they should be if this Act had never byn made, and of none other.*

This has been interpreted by the British courts to embrace a process; but a wider field of subject-matter is permitted in the United States than is possible under the foregoing section. In the latter country, and apart from patents for designs, a patent may be obtained by any person who has invented or discovered any new and useful art, machine, or composition of matter, or any new or useful improvement thereof, not known or used by others in the United States, and not patented or described in any printed publication before his invention or discovery thereof, and not in public use or on sale therein for more than two years prior to his application.†

The widest construction is allowed in American practice under these provisions, many patents being issued for the slightest step in the art to which they relate, the improvement being so small as to require the most refined discrimination for its discovery. Such patents frequently form one of a series of almost similar microscopical inventions that would certainly be covered by a single patent in England, or by one or more patents of addition in France, Belgium, or Italy. They arise in adapting a known invention to conditions slightly different from those ordinarily met with, or by slight changes in form, function, or arrangement of the elements employed, to save cost, time, or some slight labour of the operators. To these refinements, and the endeavour of rivals to evade or improve upon them, much of the advance of American industry is due, and the aggregate effect is to intensify European admiration of American ingenuity.

In several of the continental countries patents are not granted for certain classes of subject-matter, however ingenious they may be. In Russia, for example, medicines, and many articles used in warfare, may not be patented; the same is the case in Switzerland with regard to chemical inventions, processes, or improvements which cannot be presented as physical objects. In Germany articles of food, medicines, and chemical products are refused, and in France medicines or similar compositions. We trace in some of these restrictions the influence of

* "Monopolies by Patents," by J. W. Gordon, London, 1897.

† "Rules of Practice," 24; Rev. Stat., sec. 4,886

the above-quoted section of the statute of monopolies, "soe as alsoe they be not contrary to the lawe nor mischevous to the State, by raisinge prices of commodities at home, or hurt of trade or generallie inconvenient."

The question of novelty is all important to every patentee, as, when this question is raised in the court, the monopoly sought must either stand or fall thereby. We know that a preliminary search for novelty is made by a government department of the United States, but, even if satisfactory, the patent granted thereon is liable to be declared invalid by the judicial branch of the same government; and this practice obtains in other countries where the like search is made. While it is apparently inconsistent for a government to take away with one hand the monopoly conferred by the other, it is probably in the interest of inventors and the public that an independent and impartial tribunal, used to the taking and sifting of evidence, should consider the question of validity in the light of specific charges, especially as considerations other than novelty may enter into the decision. Nevertheless it is believed by many inventors that a government issuing a patent should guarantee its validity, especially where the preliminary search for novelty has been made; and this view meets with some slight response in Russia and Germany, where an infringer is liable, under certain circumstances, to imprisonment, as if he were deemed guilty of a minor act of high treason in violating a grant conferred by the sovereign.

There are many practical reasons against guarantee by industrial nations of the patents they issue, however satisfactory it might be to disappointed inventors. To do so would probably revive some of the grievances sustained under the rule of Queen Elizabeth, or such as obtain at the present time under concessions given by oriental despots to their favourites. It is better to throw the onus entirely upon the patentee in express terms, as is done in Great Britain, where he is warned in the patent "provided that these our Letters Patent are on this condition, that, if at any time during the said term it be made to appear to us, our heirs or successors, or any six or more of our Privy Council, that this our grant is contrary to law, or prejudicial or inconvenient to our subjects in general, or that the said invention is not a new invention as to the public use and exercise thereof within our United Kingdom of Great Britain and Ireland, and Isle of Man, or that the said patentee is not the first and true inventor thereof within this realm as aforesaid, these our letters patent shall forthwith determine, and be void to all intents and purposes, notwithstanding anything hereinbefore contained." In France the patentee is obliged to mark the patented article with an inscription in full, or the initial

letters thereof, S. G. D. G., indicating that it is without the guarantee of the government, thus warning the public that all concerned must themselves investigate the validity of the grant, or the usefulness of the article.

Wherever an examination for novelty precedes the grant of a patent, the official examiner necessarily has the power of rejection; and, as important inventions have frequently been deemed at the outset to possess little, if any, patentability, this power of rejection is considered by many as the greatest defect of the system. To enable the examiner to make the required search, it is essential that all prior subject-matter be carefully analysed and sub-divided into suitable classes for reference; and, unless this is done accurately, and kept up to date, the system becomes illusive, and even dangerous to those depending upon its supposed advantages, as invalid patents would be issued after a supposed complete search had been made. In Germany eighty-nine classes of subject-matter have been established to facilitate searches; in the United States two hundred and twenty-five classes existed at the beginning of 1897, and these were again minutely sub-divided, Class 39—fences—alone having ninety-nine sub-classes, while changes are constantly being made. The British arrangement comprises one hundred and forty-six classes, but, no official search being made, the classification enables an interested person to search for himself, and this is further facilitated of late by the publication of a series of abstracts of specifications relating to the several classes. A brief description with an illustration, but without the claims, is generally given for each patent; and volumes at a cheap rate, referring to different periods from 1617, are now being issued, and will be brought up to date as soon as it can be done by the limited staff available.

The report of a United States examiner almost always necessitates re-drawing of the claims to avoid the prior references he cites; and, as functional claims are rarely permitted, the claims usually take the form of combinations of the operative elements employed in performing a particular action or function required in co-operating to the general result. These claims are often most ingeniously worded, and drawn with the most minute discrimination, yet so as to carry the widest possible interpretation. The claims thus become very numerous, in order to cover the whole of an invention, but modifications of importance must be separately covered by other patents. In England functional claims and several modifications frequently appear in one specification, but with few claims, and those of a much wider scope than the American ones. The British claims, however, are automatically restricted in number, for (in cases of infringement), if one

claim only is bad, it vitiates the patent, even though that particular claim was not infringed, and not otherwise brought into the action. The German claims are still broader than the British, and more liberally interpreted in the courts, being required to refer to the general nature of the invention, and not to particular subordinate combinations, while the French practice lies somewhat between the British and the German.

It may be useful to point out, in conclusion, that, while but one copy of the specification and of each sheet of drawings is required at the Washington office, two copies of each are required in England, France, Belgium, Germany, and many other countries, the reason for the differences varying. In the United States the examiner himself is empowered to make the alterations required on the filed specification, and the office may be employed to correct the drawings. In England the examiners are prohibited from doing this, the originals being returned to the applicant or his agent for the purpose, and the duplicate set kept as a check upon unauthorized amendments, and for public reference while the original is at the printers. In Germany the duplicate is kept for similar reasons; but in Belgium and several other countries, where they do not print the specifications and drawings (or, as in France, only those which survive after a certain time), the duplicate set is stamped and returned with the Letters Patent to the applicant for his keeping. In Italy three copies of the drawings and specifications are required, in order that one set may be filed at Turin, the former capital of the kingdom of Sardinia, and the second set at Rome, the capital of united Italy. India requires five copies of the drawings and specifications, one being filed in each of the presidencies or provinces, and one in Burmah.

BACTERIAL PROCESSES OF SEWAGE PURIFICATION.

By Rudolph Hering.

IN a previous article the conditions were discussed under which sewage can be finally disposed of, without offence, by dilution in large bodies of running water. In the present article conditions are to be assumed under which such dilution is impracticable or improper, so that the sewage must be purified before it is discharged into a water-course.

Here again we are met at once with the fact that, if we seek a single method adapted to all conditions, no solution of the problem is possible. There are several methods that will give satisfactory results, and the immediate surrounding circumstances must govern the selection of the one to be applied. To do this, we have again certain guiding lines which are well fixed, and which will be discussed below.

Sewage is water polluted by organic matter partly suspended and partly dissolved therein. It contains also bacteria in great quantities, some of which are disease-producing, but most of which are engaged in the work of transforming lifeless organic into inorganic matter. Nitrogenous matter, being less stable than carbonaceous matter, is more rapidly attacked by them, and converted into nitric acid, which, uniting with the bases present, finally produces nitrates.

The purification of sewage is, therefore, a process of destruction of this organic matter by means of bacteria, and, finally, of the bacteria themselves from inanition. It necessitates their cultivation, and a provision of the most suitable conditions for their life and propagation, until the organic matter shall be converted and the conditions of their existence shall cease. If we think of fermentation, and its cause and effect, we get an idea of the process.

Through Pasteur and others, much is already known concerning these important low forms of life. We are here concerned only with their chief conditions for action. Pasteur divided them into two classes, the aerobic and anaerobic bacteria,—that is, those which need oxygen for their growth, and those which do not. The aerobies do their best work when the sewage is exposed to air; they produce oxidation. The anaerobies do their best work when air is excluded; they produce putrefaction. A further condition of active life is a warm temperature of the sewage, although freezing temperature, while reducing the activity of the bacteria, does not destroy all of them.

The aerobic process, when applied to organic matter in suspension, is slower than the anaerobic process. It takes a long time for

solid particles of organic matter to disappear as such, when the conversion depends on the oxygen contained in the water. It takes a short time, when it is brought about by anaerobic bacteria, which produce conditions causing a liquefaction of the solid organic matter.

The reverse seems true in the case of organic matter in solution, because the aerobic bacteria, or conditions favoring a thorough aeration of liquid sewage, will remove a much greater amount of organic matter from the water in the same time than if it is left to the action of anaerobies.

The practical application hereof is the fact that putrefaction hastens the destruction of solid organic matter, by converting it into liquids, while oxidation hastens the destruction of liquid organic matter, by converting it into soluble mineral matter. So far as concomitant effects are concerned, putrefaction causes offensive odors, while the effects of oxidation are imperceptible to the senses.

After these preliminary remarks, we are prepared to examine the principal methods of sewage-purification as they have been successfully practised for some time, and especially some recent suggestions that have been subjected to experiment and are now, so to speak, on trial. As the former have been frequently and fully described elsewhere, they shall be mentioned merely by reference.

The investigations of E. Frankland, Warrington, Sorby, and Dupré in England, of Schloesing, Muntz, and Marié Davy in Paris, and of Alex. Muller and others, in Berlin, first demonstrated in various ways the fact, now well established, that the purification of sewage is accomplished by bacterial action. In 1872 the Berlin Sewerage Commission reported that sewage matter was converted into nitrates, not by a simple molecular process, but by organisms always found in sewage. Early in the same decade Bailey Denton, in England, built the first artificial sewage-filtration works, where the sewage was caused to filter intermittently through beds of sandy earth, in such a manner that the organic matter was converted into nitrates by oxidation within the pores of the soil.

In the report of the Massachusetts State Board of Health, dated January, 1888, it is said with reference to purifying the sewage by intermittent filtration: "At the present no one can tell, in regard to any area that may be selected, the character of the effluent water that will result from the application of sewage in large or small quantities, nor the effect of our winters nor of long storms upon the efficiency of the beds, nor the proper intervals for application. This knowledge can be obtained only by trial and careful observation."

The subsequent experiments concerning these questions, undertaken by the board and reported in 1890, demonstrated the nature of



GENERAL VIEW OF SEWAGE FILTERS AT EXETER.

the process of sewage-purification accomplished by intermittent filtration and aerobic bacteria, and gave the world some fundamental data by which it thereafter became practicable to ascertain the degree of purification that can be expected from certain porous materials, from their physical properties, such as the size of the grains, and from different methods of operating the processes. There are to day a number of sewage-disposal plants successfully operated on aerobic principles, both in Europe and America, which confirm the conclusions of the Massachusetts board.

This method of disposal is clearly practicable only in localities where a sufficient area of porous land is available, upon which the crude sewage can be spread in suitable quantity, into which it can filter with the proper velocity, and from which it can emerge as a thoroughly-purified water. There are localities where the suitable land is scarce, too expensive for the purpose, or wholly absent. In such cases other methods of disposal are necessary.

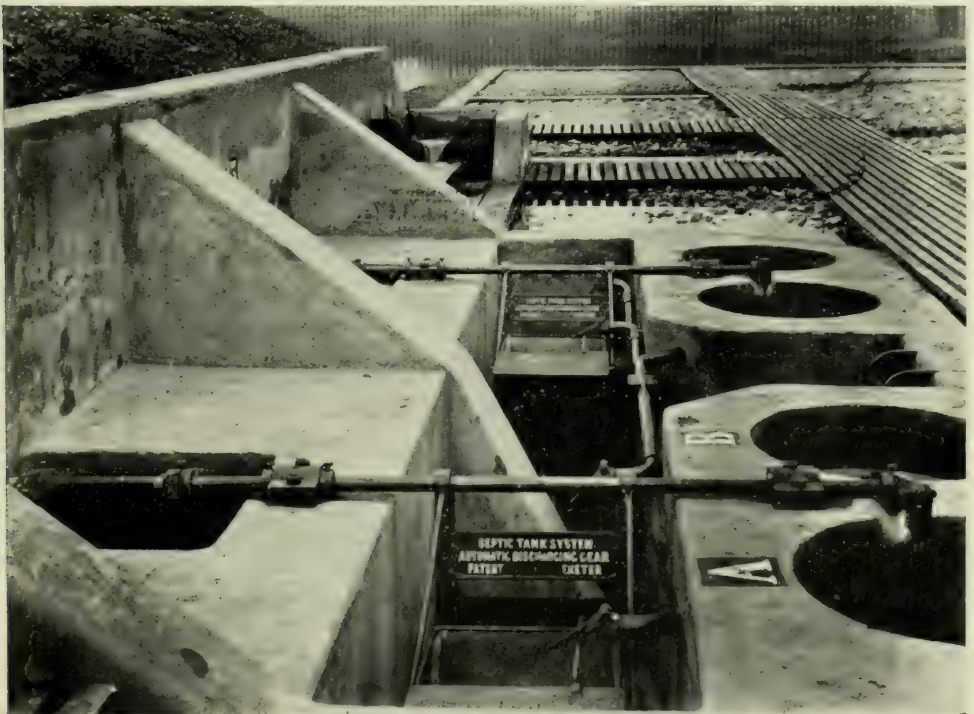
It was said above that sewage liquids are oxidized more rapidly than suspended solid matter. Therefore separation was suggested, subjecting only the clarified sewage to filtration, and thus requiring much less filter-area. The separation was accomplished in nearly all cases by a chemical precipitation of the solid particles. The principal chemicals used were milk of lime and salts of iron. The precipitated matter formed a sludge on the bottom of the settling tanks, and

at intervals had to be taken out, freed from most of its water in filter presses, and then removed.

The precipitation processes have been common in England. They remove about one-half of the total organic matter, and the purification of the remaining clarified liquid is accomplished by the aerobic bacterial process. On account of the expense of precipitating the suspended matter, and the endeavor to save money, such works have not always received the care necessary to render them inoffensive, and other ways of accomplishing the object have been sought.

Recently another method has been extensively tried and is much spoken of,—namely, the liquefaction of the solid organic matter, through the aid of anaerobic bacteria, which, it is claimed, materially reduces the expense of treatment.

In a French periodical, *Cosmos-les Mondes* (December, 1881, p. 622, and January, 1882, p. 97), there is an article on the Mouras Automatic Scavenger, which is described as a “mysterious contrivance” that has been used for twenty years. It consists of a vault hermetically closed by an hydraulic seal. “By a mysterious operation, and one which reveals an entirely novel principle, it rapidly transforms all” the excrementitious matter which “it receives into a homogeneous fluid, only slightly turbid, and holding all the solid matters in suspension in the form of scarcely-visible filaments.” The



ALTERNATING GEAR FOR CONTROLLING FILLING OF SEWAGE FILTERS AT EXETER.



SEWAGE DISPOSAL WORKS AT YEOVIL.

vault is self-emptying, and continuous in its working. "The liquid which escapes, while it contains all the organic and inorganic elements of the fæces, is almost devoid of smell, and can be received into a watering-cart for horticultural purposes, or may pass away into the sewer for use in irrigation."

Passing on to the theory of the action, it is then said: "May not the unseen agents be those vibriions or anaerobies which, according to Pasteur, are destroyed by oxygen, and only manifest their activity in vessels from which the air is excluded?" Daily observations conducted with a glass model showed that "fæcal matters introduced on the 29th of August were entirely dissolved on the 16th of September." "Even kitchen refuse, onion peelings, etc., which at first floated on the surface, descended after a time to the bottom of the vessel, and awaited decomposition. Everything capable of being dissolved acted in a similar way, and even paper wholly disappeared."

It is further said: "The principles on which M. Mouras bases the action of this machine is that the animal dejecta contain within themselves all the principles of fermentation or of dissolution necessary and sufficient to liquefy them, and to render them immediately useful in their return to the soil and without appreciable loss."

In a later article of the *Cosmos-les-Mondes* (January, 1883, p. 110), entitled "Theory and Accurate Working of the Automatic Scavenger," and written by Abbé F. Moigno, certain additional information is given, by which the proper dimensions of such a tank may be



GENERAL VIEW OF SEWAGE FILTERS AT SUTTON, SURREY.

In the background are seen the covered tanks formerly used in the chemical treatment.

ascertained. M. Mouras is reported to have made the following statements. For the complete solution of the floating solid matter a period of thirty days should be allowed. The superficial area of the tank should be $\frac{1}{10}$ metre per person. The thickness of the top layer of undissolved solid matter should not exceed 0.075 metre (say, 3 inches). The depth of the deposit is assumed as 0.02 metre (say, 1 inch). The depth of the submerged portion of the outflow pipe below the surface should be 0.18 metre (say, 7 inches).

If we assume :

v = daily volume of excreta per person,

n = number of persons,

a = area of tank,

d = depth of tank, which should be at least one metre, if only excreta entered it,

s = thickness of floating layer of undecomposed solids,

c = thickness of layer of deposited detritus,

then the size of the necessary tank may be ascertained from the following formula :

$$a = \frac{30 v n}{s}$$

$$d = 1 \text{ metre} + n c$$

From the description of this interesting contrivance, it will be seen that the process of anaerobic decomposition was practically applied



UPPER OR BACTERIAL BEDS ; SUTTON SEWAGE DISPOSAL PLANT.

The sewage is entering the nearest filter.

many years ago. It does not seem to have been suggested, however, as a method to be adopted on a large scale, until it was introduced at Exeter, England, in 1896, by Mr. Donald Cameron, city engineer.

This plant was built to purify the sewage of about 1,500 persons. It consists of three parts :

(1) The grit chambers, where mainly road washings are retained, and from which they can be separately removed.

(2) The septic tank, in which the liquefaction of the suspended sewage matter is said to be accomplished within about twenty-four hours, and which closely resembles the Mouras scavenger.

(3) The filters, where the effluent from the tank is finally purified by filtration.

The part concerning us most at present is the septic tank. It holds one day's supply of sewage, and is about 65 feet long, 18 feet wide, and 7 to $7\frac{1}{4}$ feet deep, and is said to have treated about 50,000 imperial gallons per day.

Dibdin found in the Exeter sewage 24.5 grains of suspended matter per imperial gallon, and in the tank effluent he found only 10.8 grains ; therefore 13.7 grains per gallon must have either remained in the tank as deposit or been liquefied. As, after several months, the floating scum was only 6 inches thick, and the sediment, consisting of fine matter, was mostly formed of nitrates, it is claimed that most

of the organic matter originally suspended must have been liquefied.

Our illustrations give several views of the Exeter works, showing the covered air-tight septic tank, the filters, and the alternating gear for controlling the charge of the filters.

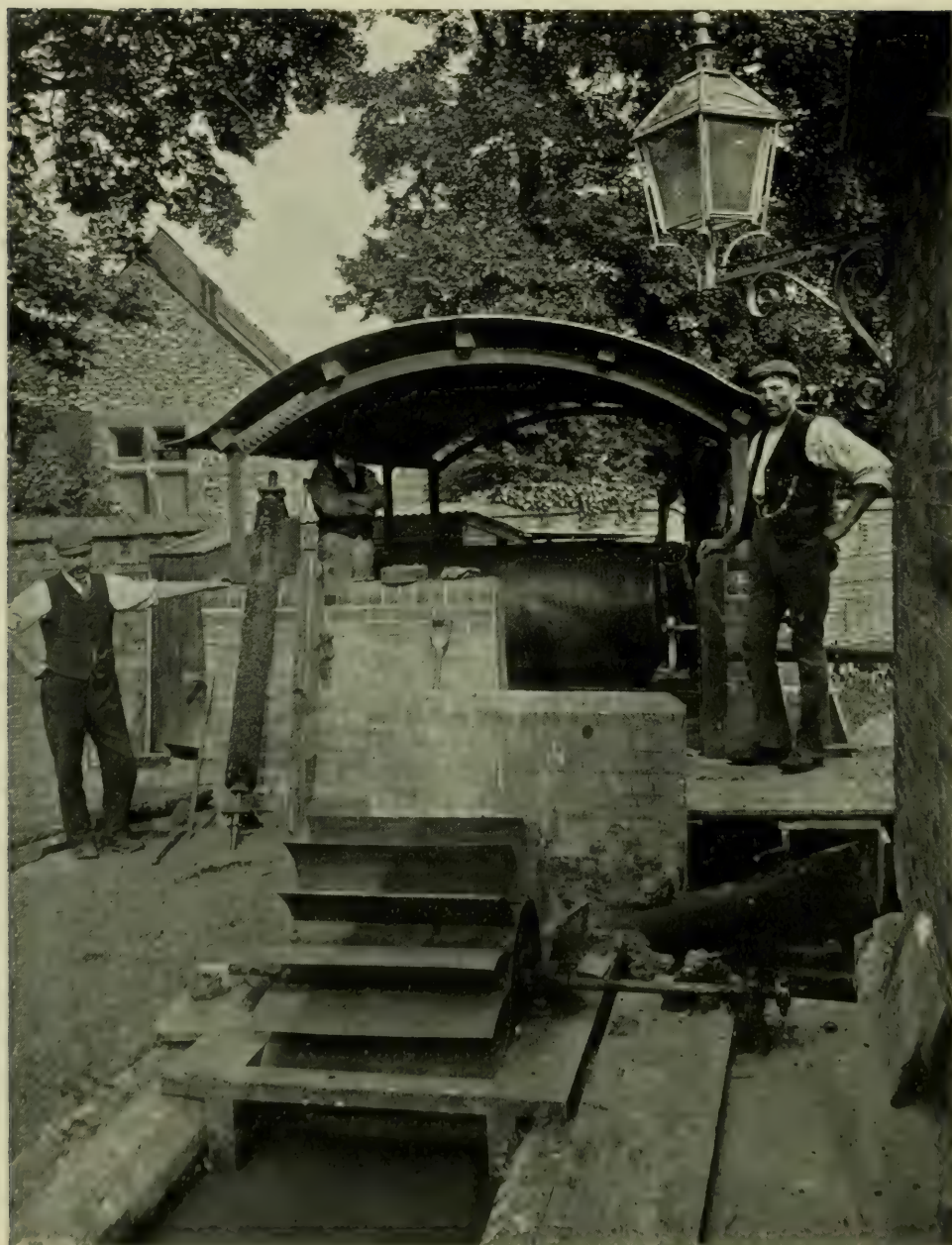
Recently the Local Government Board of England made an examination of the Exeter works and a report thereon. It comes to the conclusion that, "if the septic process be adopted, a further treatment of the sewage on land will still be required, previous to the effluent being discharged into the river." It would "approve of the scheme on the distinct understanding that the city council, in adopt-



LOWER, OR "FINE BEDS"; SUTTON SEWAGE DISPOSAL PLANT.

ing this system as an experimental substitute for the ordinary process of chemical precipitation, will accept the entire responsibility for the experiment, and will give an undertaking that, in the event of the process failing to give satisfactory results when applied to the sewage of the entire city, they will adopt in its place some process of treating the sewage with chemicals combined with artificial filtration." With regard to the quantity of land required, the board orders that the city provide itself for this purpose with one acre for each 2,000 of the population,—about the amount required for treating the effluent water from chemical precipitation works.

The Exeter works have been in operation now almost two years, and the continued results will be watched with much interest.



PERFORATED SCREEN FOR REMOVING SOLID MATTER FROM SEWAGE AT SUTTON.

The screen is revolved by water power, the sewage current operating the wheel.

The septic-tank system has recently also been introduced at Yeovil. Much of the sewage contains refuse from works engaged in the manufacture of glove leather, and is said to be of an especially obnoxious character. In addition to the organic impurities, it contains arsenic and other poisons. It is reported that, notwithstanding the unfavorable character of the sewage, the treatment has been greatly facilitated by the preliminary septic process to which it is there sub-

jected. It seems from the statement that sewage containing manufacturing refuse may likewise be purified by the bacterial process. One of our illustrations shows a view of the Yeovil works.

There is little information as yet regarding the actual cost of constructing and operating works using the septic process. Semi official statements have been made in England that, for a large population, the cost of installation is two dollars per head, and for a small population three to four dollars per head. It is not stated, however, whether this cost includes that of the necessary subsequent filtration.

There are still other methods now brought to our attention in England; of these the most prominently mentioned are the works at Sutton, Surrey.

Mainly through the suggestions and efforts of Mr. W. J. Dibdin, late chemist to the London County Council, a novel method of destroying the suspended matter of sewage has lately been adopted in Sutton. The principles which Mr. Dibdin advocates are stated as follows:

“As a preliminary it will be advisable to remove as many of the particles as possible by mechanical separation, by passing the sewage through a screen having as fine a mesh as possible. Although much has been done in this direction, . . . the best and most economical method has yet to be worked out.” “What is really required is straining through a self-cleansing mesh, sufficiently fine to collect the fibers of paper, etc.”

“Filtration, on biological lines, of sewage, or other foul water containing in solution but little free oxygen and a large quantity of oxidizable organic matter, means:

“(1) That the filter, by cautious increments in the quantity of effluent, which in itself contains the necessary organisms, must be gradually brought to a state of high efficiency. This condition will be shown by the existence in the filtrate of a constantly-increasing proportion of nitric acid.

(2) That the contact of the micro-organisms with the effluent to be purified must be effected by leaving such effluent to rest in the filter for a greater or less time, according to the degree of purification required, the process being analogous to that of fermentation.

(3) That, after each quantity of effluent has been dealt with, the micro-organisms must be supplied with air, which is readily effected by emptying the filter from below, whereby air is drawn into the interstices. The filter must stand empty for an hour or more previous to another filling, and a longer period of aeration—say, twenty-four hours—must be allowed every seven or eight days.” (Report to London County Council, October, 1895.)

Mr. Dibdin, in 1895, made experiments with small filters and various filtering materials, on which he reported to the London County Council the following results :

“ The average rate of working, including rest periods, was 411,000 gallons per acre in 24 hours. The mechanical cleansing, or clarification, is shown as follows, the figures representing units of depth required to obscure a standard mark :

Burnt ballast.....	1
Coke breeze.....	1
Pea ballast.....	1 $\frac{3}{4}$
Sand (1st portion of compound filter).....	2 $\frac{1}{4}$
Proprietary article (2nd portion of compound filter).....	2 $\frac{1}{2}$

“ The following table shows the extent of the purification effected, as indicated by the reduction in oxidisable organic matter in solution :

Burnt ballast.....	43.3 per cent.
Sand (1st portion of compound filter).....	46.6 “ “
Pea ballast.....	52.3 “ “
Proprietary article and sand combined.....	61.6 “ “
Coke breeze.....	62.2 “ “ ”

From these results it appeared that for foul waters sand proved too fine and burnt ballast too coarse. Coke breeze seemed to unite the necessary qualifications. In the Massachusetts experiments the results obtained with sand have apparently been more favorable than in the London experiments.

A brief description of the Sutton sewage works, given by Mr. C. Chambers Smith, surveyor to the Sutton council, is about as follows. The population of the district draining into the present works is about thirteen thousand. The daily dry-weather flow of the sewage is 350,000 gallons. The sewerage works are strictly on the separate system. The accompanying illustrations exhibit the plant.

Previous to the introduction of the new works, the sewage, on arriving at the outfall, had been treated mechanically with lime and iron, in the proportions of two grains of iron and nine grains of lime per imperial gallon, and then passed into precipitation tanks, six in number. After subsidence, the supernatant water was run off upon the artificial filter or upon the land, as circumstances permitted.

The consideration of the new crude-sewage filter, or “ bacteria tank,” as it is there called, was commenced early in November, 1896, by using one of the precipitation tanks for the purpose. It has an area of about 183 square yards, on the floor of which was laid a six-inch main drain, with three-inch branch drains, nineteen in number, running to the side walls. The main pipe can be closed with a

valve, and shut down when the tank is being filled, and is full.

The joints of the pipes are open, and covered with the coarsest of the material. The tank is then filled with so-called ballast, consisting of broken-up burnt clay. The average depth of the ballast in the filter is 3 feet 6 inches. Care was taken to exclude the dust and whatever fine material passed through a screen of one half-inch mesh.

The filter can hold 13,500 imperial gallons of sewage, the proportions being approximately one-third sewage and two-thirds ballast. The flow of sewage per square yard is 186 gallons per day, and, per cubic yard of the material, 139 gallons per day. At the rate per acre the daily quantity of sewage would be about 900,000 gallons.

An automatic rotary screen is used to intercept the floating paper, etc., before the sewage is applied to the tanks.

The bacteria tank is reported to have been in daily work since November 21, 1896, treating, on an average, 30,000 gallons per day. The "tank" is charged twice, or sometimes three times, a day, after passing the sewage through screens, to intercept the larger pieces of floating matter.

The time occupied in filling is about three-quarters of an hour. Care is taken to prevent the sewage from reaching the surface, by stopping the flow as soon as the sewage-level rises to within a few inches of the top of the bed; thus light is excluded. The "tank" is then allowed to remain charged for about two hours, during which time the anaerobies have their opportunity to work, after which the valve is opened and the "fermenting" sewage flows out. The time occupied in emptying is about one hour and a quarter. The "tank" is then allowed a rest of two hours, when the aerobic bacteria are supposed to do their share of the work, after which it is again charged, the cycle occupying six hours. Mr. Smith states that the material remains inoffensive.

The total quantity of sewage treated in this manner up to March 31, 1898, is given as 16,598,365 imperial gallons. Mr. Dibdin estimates that in the tank 57.25 grains of the original 60 grains of suspended matter per gallon had been absorbed, equalling 603 tons of sludge.

Three tanks filled with coarse-grained material have recently been added, constructed like the first, and it is reported that a sufficient number will be added to treat the entire sewage-flow of the city in this manner.

After the sewage has been passed through these coarse-grained "bacteria tanks," it is passed through fine-grained tanks, or filters, of which eventually eight are to be provided for purifying the entire quantity of effluent from the former.

The fine-grained filters are composed of various materials,—coke breeze, sand, gravel, and burnt ballast,—the grains of the latter not exceeding three-eighths of an inch in diameter.

The reduction of the oxidizable matters in solution is reported by Mr. Dibdin to be from about 4.54 to 1.67 grains per imperial gallon in the "bacteria tank," or coarse filter, and finally to about 0.64 grain in the fine filters, showing an average reduction of about 63 per cent. by the coarse, and a further reduction of 22 per cent. by the fine, filters, or 85 per cent. in all.

The nitrogenous organic matter, as indicated by the albuminoid ammonia, was in like manner reduced 58.45 per cent. in the coarse, and 20.09 per cent. in the fine, filters, or 78.54 per cent. in all.

The matters in suspension in the crude sewage are reduced from 60.03 to 2.78 grains per imperial gallon in the coarse filter, and still further to 0.725 grains per gallon in the filtrate issuing from the fine coke-breeze filter.

While we cannot doubt the correctness of the analyses given to the world by Mr. Dibdin, the time which has passed since the Sutton filters were first operated is hardly sufficient to give results which can be permanently relied upon; nor does the element of cost of construction and annual operation seem to have been definitely determined as yet.

There can be no doubt that this process will yield pure water, if the applied sewage is previously freed from suspended matters, and if there is not enough poisonous matter in the sewage to destroy the useful bacteria. The difficulties which may be expected in the Sutton process lie in the possible gradual filling-up of the filters with slowly-oxidizable vegetable matter not strained out by the screens. It is difficult to operate economically a strainer fine enough to keep out fibrous vegetable material. A plant similar to the one in Sutton has been operated at Leeds, and there it has been found that the sludging-up of the beds was one of the chief difficulties. It was also found that, after a fortnight's rest of a filter, the flow was materially increased. But a permanent relation between the length of time during which the retained fibrous sewage matter is removed by oxidization and the amount of sewage that can be permanently filtered per square foot of filter area has not yet been found.

All we can safely say at the present time is that both the Exeter and Sutton experiments not only are interesting, but promise to improve the present methods of sewage-disposal where suitable land for slow filtration is not available, although perhaps the improvement may not be as great as anticipated by the promoters.

Still another suggestion has recently been made by Mr. Walter M.

Ducat, who recommends a number of artificially-constructed filters, resting one over the other in such a manner that a continuous aeration of the entire filter, from top, bottom, and sides, is supposed to take place automatically. The beds are so arranged that the coarse material is uppermost, and the finest at the bottom. Whether or not any works have been constructed on this principle, except for a short experiment on a small scale, does not appear. But it may safely be stated that, unless such a filter were charged with a clarified effluent, or, in other words, sewage entirely freed from suspended matter, it would sooner or later become filled up and cease to operate.

To return to our introductory considerations, it appears that, with a limited amount of land, permanent success in purifying sewage can be accomplished only by a prior separation of the suspended and dissolved organic matter. Organic matter in solution can be thoroughly purified by aerobic bacteria, and in large quantities per acre, in properly-devised filters of sand, coke breeze, or similar porous and permanent material, operated intermittently. Undoubtedly, also, some fine fibrous or globular nitrogenous matter may also be removed by this relatively rapid process. But the organic matter in suspension requires a preliminary separate treatment, either, first, by a system of chemical precipitation, or, secondly, by a system of liquefaction as accomplished in the septic tank, by which the quantity of sludge is at least very greatly reduced, or, thirdly, by a preliminary very fine screening with a subsequent liquefaction of the remaining suspended matter in a so-called bacteria tank.

Whether the first, second, or third method will prevail in the future depends largely on the question of cost of obtaining satisfactory results which may be ascertained from the experience now being gained.

In conclusion, I beg to render my thanks to Mr. A. S. Crane, C. E., who has furnished illustrations accompanying this article, to Mr. Donald Cameron, and to Mr. W. J. Dibdin, from whose reports numerous extracts have been made.

THE APPLICATION OF ALTERNATING CURRENTS TO ELECTRIC TRACTION.

By Charles Henry Davis and Howard C. Forbes.

II.

IN the last number of THE ENGINEERING MAGAZINE we discussed, in a general way, the question of transmitting electric power from a waterfall, or other cheap source, to a steam railroad, by means of the alternating current, and the operation of such a road by electric motors; and we showed:

(1) That the alternating-current motor of to-day cannot be directly applied to operating railroad trains, either on the axles of the cars or at the head of the train as a locomotive, because of the difficulties in starting under load and in controlling the necessary variations in speed.

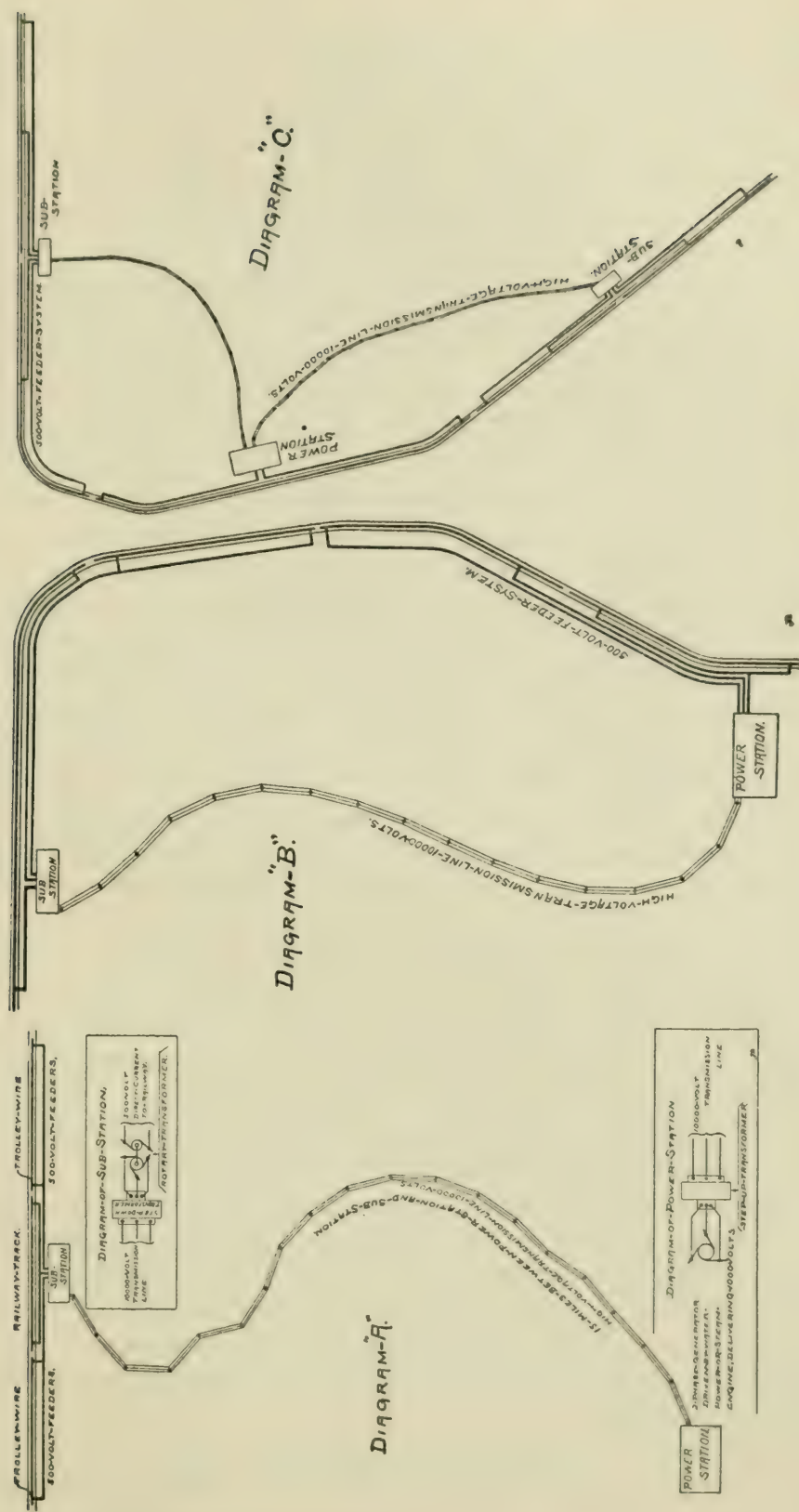
(2) That the alternating current can be indirectly applied to operating railways, because of the facility with which we can transform it to high potentials for long-distance transmission.

Let us, now, consider in detail the indirect application of alternating currents to railway work. We shall describe three general cases, and then consider specifically the problem of a new road built for very high speed, with trains at frequent intervals, comparing the relative first cost and operating expenses, assuming electric power to be obtained from a cheap source at a distance, with the corresponding charges, and assuming the usual power stations located at intervals along the road.

In the use of alternating currents in railway work there are three typical cases. These are illustrated by the diagrams as follows:

- (1) Diagram A. Where the source of power is located a considerable distance from the line of railway.
- (2) Diagram B. Where the source of power is located at one end of the railway line.
- (3) Diagram C. Where the source of power is located at the middle of the railway line, or section thereof.

The first case (Diagram A) arises where the entire line of railway is located a long distance from the water-power which it is desired to utilize. This is the most common case, especially in street railway work, for many of the smaller water-powers and some of the larger are now being developed, and their power transmitted 15 to 20 miles or even more, by means of two- or three-phase alternating electric



DIAGRAMS SHOWING ARRANGEMENTS FOR VARIOUS LOCATIONS OF POWER STATIONS.

currents. The second case (Diagram B) also occurs with street railways where the track runs to some point near a water-power. At the power station, in this case, is located a generator which delivers both alternating and direct current; this generator is similar in construction to the "rotary transformer," except that it is driven by a water wheel. The direct current is applied immediately to the feeders and trolley wire for that portion of the road which lies near the power station, while the alternating current goes to the step-up transformer which raises the voltage for transmission to the sub-stations near the other parts of the line. At the sub-station the method is similar to that already described, the current passing to the step-down transformer and being changed to direct current by the rotary transformer as before. The third case (Diagram C) represents a method that can be used in operating a long line of steam railroad by electricity. The road could be divided into sections with a main power station in the center of each section, if the power were to be derived from coal in the usual way. These sections could then be divided into sub-sections, each with its sub-station, and the power transmitted from the main station to the sub-stations by alternating current at high voltage. At the sub-stations the alternating current could be transformed to direct current suitable for use by the railroad motors, as already described. The sub-sections nearest the main power stations could be operated directly from these stations, either by the use of generators delivering both alternating and direct currents, or, if a large amount of power were required, by separate direct-current machines.

If a steam railroad were operated by electric traction, the method of applying electricity along the line would probably be that shown by Diagram A, where a cheap source of power located at a distance is utilized, or that shown by Diagram C, where the power is generated near the railroad by the use of coal. The question arises, therefore, under what conditions would the cheap source of power be used, and what are the limits of its application. As we have pointed out, the tendency of many writers on this subject is to consider that the cheap source of power, coupled with alternating-current transmission at high voltages, will solve the problem of electric traction for steam railroads. This may prove to be so in the future, when we are able to use the alternating current motor without conversion and multiphase currents at much higher pressures than are now feasible,—say, one or two hundred thousand volts.

To enable us to intelligently compare the relative first cost and operating expenses of the two methods,—*viz.*, "cheap source" of power located at a distance, and the application of power from points

along the line of railway,—we shall consider a definite case, chosen with a view to deducing as general conclusions as possible. We assume, therefore, a proposed road connecting New York harbor with Philadelphia, an outline of which was given in *THE ENGINEERING MAGAZINE* (October and November, 1897) under title of “The Enormous Possibilities of Rapid Electric Travel.” This case is one where electric traction is the only satisfactory or profitable solution. For the purposes of our comparison, we shall assume that such a road is feasible both from a physical and a commercial point of view, and we shall show the relative cost of applying electric power under two conditions,—namely, Case 1, Diagram A, where the source of cheap power is “available within a few hundred miles of a trunk line of railway,” and Case 3, Diagram C, where power stations are located in the middle of various sections of the same trunk line. We shall show how fallacious is the usual assumption that, with our present appliances and knowledge, the utilization of a “cheap source” of power results in greater economy than the use of power stations located as close to the application of power as possible; and we shall do this by giving the “cheap source” the benefit of every doubt.

Diagram D shows the layout of the railroad and feeder lines for the former case, where a cheap source of power is utilized, and Diagram E shows the layout for the latter case, where the power is generated by power stations located at intervals along the railroad.

We assume the following conditions:

Case 1 (Diagram D):

- a. Unlimited amount of water power.
- b. Two sources of power each, 100 miles from the line of railway (85 miles long) and dividing same into $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{1}{4}$.
- c. Development of these water powers to cost no more than eleven power stations in Case 3 (this is highly unlikely, but favors Case 1 as against Case 3).
- d. Three-phase alternating current of 20,000 volts to be used from source of power to sub stations, and 1,000 volts direct current from sub-stations to railway motors (this favors Case 1 as against Case 3).
- e. Sections 8.5 miles long (44,892 feet).
- f. Sub-sections 11,223 feet long, 30 in all, each with a sub-station rotary transformer plant.
- g. Three tracks, minimum headway on each, three minutes; trains of five cars each, being 8.5 miles apart.
- h. Each train will require not more than 10,000 i. h. p. at the stations, under economical conditions.

- i.* Each sub-station an economical rating of 20,000 i. h. p.
- j.* In either case feeder lines along the line of railway equal each other (this also favors Case 1 as against Case 3).
- k.* All other conditions to be the same as assumed in the article, referred to above, entitled "The Enormous Possibilities of Rapid Electric Travel."

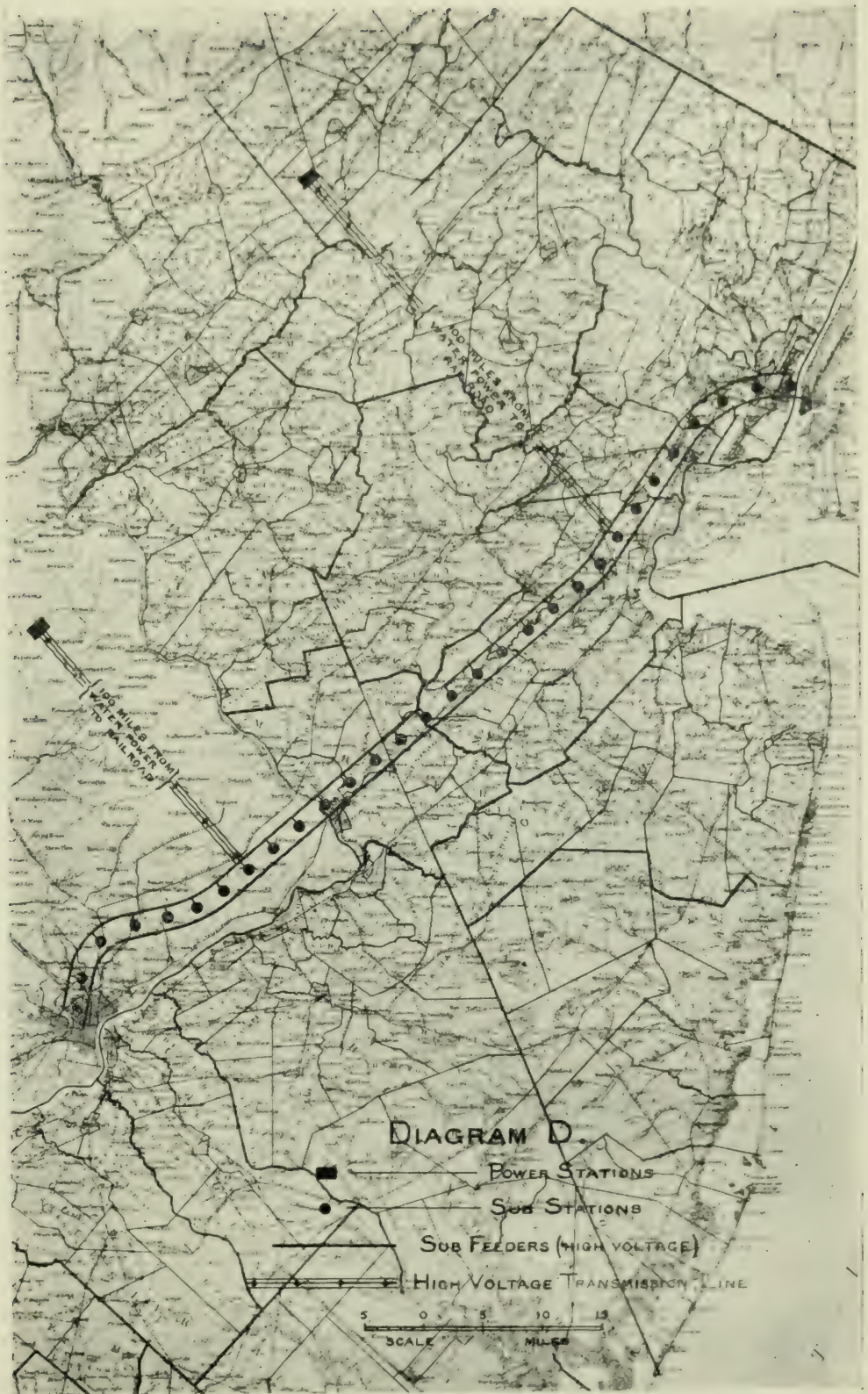
Case 3 (Diagram E) :

- a.* Eleven power stations, one for each section and one at each end of the line, 8.5 miles apart, each supplying current to 3 sub-stations with rotary transformers—sub-stations 2.125 miles apart.
- b.* Cost of the eleven power stations, each 30,000 i.h.p. economical rating to equal the cost of developing water powers in Case 1 (favoring Case 1 as against Case 3).
- c.* Three-phase alternating current of 10,000 volts from power stations to sub stations, and 1,000 volts direct current from sub-stations to railway motors (this favors Case 1 as against Case 3).
- d.* All other conditions similar to *e, f, g, h, i, j,* and *k,* of Case 1.

From diagrams D and E it will be seen that the track, third rail, direct-current feeders, sub-stations, etc., will be the same in both cases. The amount of copper in the high-voltage sub-feeders in Diagram D, which run from the point where the transmission line strikes the road to the sub-station either way, would be greater than that in the high-voltage lines from the power stations to the sub-stations in Diagram E. The main point to consider, however, is the high-voltage transmission lines themselves (Diagram D) from the water powers to the point where they strike the line of the railroad. Under the above conditions, if the interest on the additional investment for these transmission lines from the "cheap source" of power to the railway line in Case 1 exceeds the difference between Case 3 and Case 1 in cost of power delivered to the sub-station supply feeders, then it is unprofitable to utilize the "cheap source" of power.

Our calculations, therefore, can be confined to the cost of the two transmission lines in Case 1, each 100 miles long, from the two sources of water power to the line of railway, and the difference in the cost of producing power, at the sub-station supply feeders. If the interest on the former exceeds the difference in the latter, then it is unprofitable to use the "cheap source" of power.

In making the calculations, every care has been taken to be fair to the distant source of power, and wherever then is any room for doubt, the "cheap source" has been given the benefit.



D. RAILWAY BETWEEN NEW YORK AND PHILADELPHIA. DISTANT WATER POWER.

We have figured the pounds of copper necessary as follows :

Circular mills
(Diam. of wires squared) = $\frac{\text{Current} \times \text{Distance in feet} \times 20}{\text{Volts lost in line.}}$

Current = $\frac{\text{Watts}}{V} = \frac{\text{Horse Power} \times 746}{\text{Voltage of transmission.}}$

Pounds of Copper = .016 × cir. mills × miles.

Therefore :

Lbs. of cu. = 1,262,000 $\frac{\text{H. P.} \times \frac{2}{\text{Miles}}}{(\text{Voltage of Trans.}) \times (\text{loss in volts})}$

For 100 miles transmission at 20,000 volts, and a loss of voltage in the line of 20 per cent, or 4,000 volts, the formula becomes :

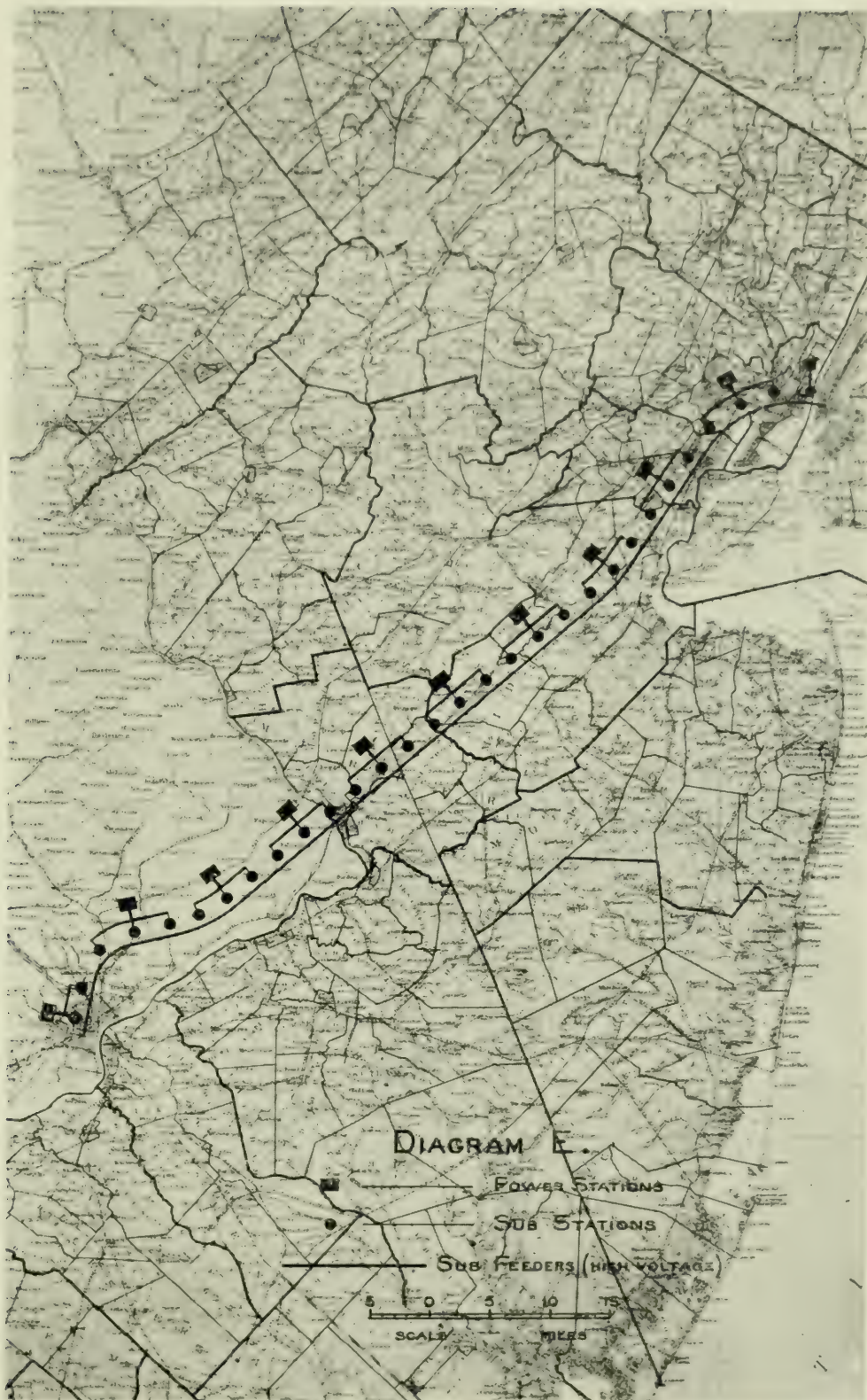
Lbs. of copper = 158 × H. P.

This is correct for direct current. For alternating, the inductive loss would increase the amount of copper required to obtain the same total percentage loss, or, if the same amount of copper is used, would increase the total percentage loss. At the same time there would be a saving due to the three-phase wiring system, which would partly counterbalance the loss due to induction. The actual formula would have to be deduced for each special case of wiring, but, on the whole, the above formula, used directly, is sufficient for our purpose.

As the horse power to be transmitted equals 412,500 at 20 per cent. loss (330,000 h.p. delivered at the railway line), the total amount of copper necessary is 65,175,000 pounds.

We therefore make the following comparison :

	Case 1.	Case 3.
Allowable loss in pressure from water powers to railway line.....	20%	.....
Total h.p. to be delivered to railway line at supply feeders of sub-stations.....	330,000	330,000
Total h.p. at source of power.....	412,500	330,000
Number of power stations.....	2	11
Total h.p. at each power station.....	206,250	30,000
Total distance, in miles, power is transmitted from each station.....	100	0
Pressure at source of power (volts).....	20,000	10,000
“ “ railway line (volts).....	16,000	10,000
“ lost in line (volts).....	4,000	0
No. of sub-stations supplied from each source.....	15	3
Average length of sub-feeders (miles).....	10.625	4.25
Number of sub stations on each group of sub-feeders.	7.5	3
Pounds of copper in transmission line.....	65,175,000	0



E. RAILWAY BETWEEN NEW YORK AND PHILADELPHIA. LOCAL POWER STATIONS.

We give below a tabulated estimate of the cost of our proposed transmission line.

Right of way—two strips 100 feet wide and 100 miles long = about 2,500 acres @ \$1,000, average.....	\$2,500,000
Engineering, 2% on \$15,000,000.....	300,000
Clearing 600 acres @ \$100.....	60,000
Bridges, viaducts, or sub-marine cables, say (an approximate estimate).....	1,500,000
Fencing.....	100,000
Crossings, say 120 @ \$1,000.....	120,000
Signals for guarding and repairing 200 miles @ \$1,000.....	200,000
Telegraph 200 miles @ \$1,000.....	200,000
Narrow-gauge repair track and equipment, 200 miles @ \$5,000.....	1,000,000
Feeders 65,175,000 pounds @ 15 c in place.....	9,780,000
Pole line, 11,000 poles set in concrete @ \$100 each... ..	1,100,000
Discount on \$25,000,000, 3% 100-year bonds.....	1,250,000
Interest on bonds to opening of road, say, 10 years of construction, averaging \$2,500,000 per annum @ 3%	4,125,000
Taxes to opening of road, assuming $\frac{1}{4}$ assessment and 2 % rate.....	1,375,000
Office expenses, salaries, etc., to opening of road, 2% on \$15,000,000.....	300,000
Contingent, etc., not itemized, to opening of road, 5.2%	1,300,000
Total cost.....	\$25,310,000

To the total cost of transmission line, amounting to \$25,000,000 (in round numbers), should be added the additional cost of developing the two water powers to 412,500 h.p. as against 330,000 h.p. in the eleven steam power stations along the railway line; also there should be added the additional cost of feeder lines from the two railway terminals of the transmission lines to the sub-stations, as against the cost of feeders from the steam power stations to the sub-stations. While these two items would undoubtedly amount to several million dollars in the case under discussion, we have omitted them, owing to the difficulty of estimating the former without accurate surveys of special localities to be developed; their omission favors Case 1. So far we have an excess in first cost of \$25,000,000 against Case 1 as compared with Case 3.

We give below a comparison of the running expenses under the two conditions, based upon the calculations in "The Enormous Possibilities of Rapid Electric Travel" already referred to, the items

being given in percentages of the total cost per car-mile run, and being reasonable averages.

	<i>Case 1.</i>	<i>Case 3.</i>
Repairs of N.G. track on transmission line		
r. of w.	1.0%	.....
Repairs of fences, crossings, etc., on transmission line r. of w.	.1%	.....
Repairs of feeder lines on transmission line r. of w.	6.0%	.....
Renewals of poles and insulation on transmission line r. of w.	1.5%	.....
Renewals of feeder on transmission line r. of w.	1.0%	.....
Repairs of bridges and trestles on transmission line r. of w.	.3%	.....
Repairs of buildings on transmission line r. of w.	.1%	.....
Repairs of signals and telegraph on transmission line r. of w.	.5%	.....
Fuel for power stations. ....	.....	8.0%
Water supply. ....	.....	1.0%
Oil and waste.	.5%	1.0%
Repairs of power stations.	2.0%	4.0%
Power station wages.	2.0%	4.0%
Average h.p. developed at source of power	412,500	330,000
Total car-miles per annum.	43,435,000	43,435,000
Total cost per car-mile. ....	.....	15 cts.
Add for excess power developed by water powers (25%) say.	3.0%	.....
All other items being the same, the reader being referred to the articles already quoted. ....	.....	.....

From the table above, it is seen that the items added to the cost per car-mile by the use of water-powers located 100 miles away about balance the greater cost of fuel, water, oil and waste, repairs to power stations, and power-station wages, where the stations are located close to the tracks and operated by steam power (each amounts to 18%). Hence the total expenses would be practically the same for each case. As the transmission lines cost \$25,000,000, the interest thereon is the total increase in the expense of utilizing the water-powers instead of steam power plants. This interest may be figured at 3 per cent. (\$750,000), 4 per cent. (\$1,000,000), 5 per cent. (\$1,250,000), 6 per cent. (\$1,500,000), or even 10 per cent. (\$2,500,000), as the

case may require or good judgment dictate. The use, therefore, of these supposed water-powers would decrease the earning capacity, instead of increasing it.

Let us, for the moment, assume that our calculations of the operating expenses with the use of water powers is inaccurate, that in many of the items there is a greater saving, and that those having no counterpart in the other column can be materially reduced.

We give the following tables :

Interest.	Car-miles.	Total Interest.	Saving in Cents per Car-mile which must take place to allow the investment.
10%	43,435,000	\$2,500,000	5.81 cts.
6%	"	1,500,000	3.68 "
5%	"	1,250,000	2.90 "
4%	"	1,000,000	2.32 "
3%	"	750,000	1.74 "

But 18 per cent. (total of per cent. items in former table) or 15 cents (assumed cost per car-mile) equals 2.7 cents; so that, at the five interest rates, we can afford to have our figures wrong by :

With interest at 10%	—266%	of 18%	=(38%	of total)
"	"	" 6%	—133%	" " =(24% " ")
"	"	" 5%	—105%	" " =(19% " ")
"	"	" 4%	—83%	" " =(15% " ")
"	"	" 3%	—64%	" " =(11% " ")

It is unlikely that we have made any such error as would be necessary to show that, even with money worth only 3 per cent., it would pay to utilize the water powers in the case we have discussed. Furthermore we have favored Case 1 in every way, and more especially by comparing a 20,000-volt system with one of 10,000 volts.

Had we used higher voltages on our transmission line, the copper would have cost :

At 50,000 volts—	63 × H.P. = 10,310,000 lbs.—	\$1,555,000.
100,000 "	—25 × H.P. = 2,600,000 lbs.—	390,000.

By using higher voltages some items of the first cost would be slightly reduced, but, as these constitute more than 60 per cent. of the total cost whereas copper constitutes less than 40 per cent., a reduction in the latter increases the percentage of the former, although reducing the actual amount. Using 100,000 volts, the first cost would not be less than \$10,000,000; the interest on this at 3 per cent. equals \$300,000, and the corresponding saving in cents per car-mile which must take place to allow this investment equals 0.7 (cents); therefore 25 per cent. of 18 per cent. (4.6 per cent. of total) can be allowed, even in this case, for errors in our calculation.

The case we have discussed shows conclusively that it would not

pay to utilize the water powers. But, it may be said, this covers only one problem. While this is true, nevertheless this problem is one chosen to enable us to arrive at a general conclusion ; for we are dealing with a very large amount of power at a comparatively short distance. The larger the power to be used, the more likely it is that a cheap source will prove profitable ; the greater the distance over which the power must be transmitted, the less likely it is that a cheap source will prove profitable.

While, undoubtedly, the utilization of water power by long-distance transmission does, in some cases, prove more profitable than other sources, and while, in the future, they may prove even more so, yet to-day the investor should be cautious about believing that a particular one will return the profits contemplated or promised. The future will see, as the past has seen, many improvements along the lines suggested herein, and these will help towards a more favorable solution than we can see to-day.

THE BAKU PETROLEUM DISTRICT OF RUSSIA.

By David A. Louis.

THE enormous extent and importance of the oil-region of south-east Russia was touched upon by me in a recent contribution to the editorial department of *THE ENGINEERING MAGAZINE*. The magnificent programme thoughtfully arranged and thoroughly and successfully carried out by the generous Russian hosts of the Seventh International Geological Congress afforded an opportunity to judge concerning the geological and other features associated with the presence of petroleum in those districts, and to form some idea of the present day magnitude and character of the world-renowned industry so long established at Baku.

On the way to Trans-Caucasia we had passed over the Caucasus mountains from Vladikavkaz to Tiflis, following the Georgian military route; and during our progress we not alone enjoyed the impressive scenery, but also examined the interesting geological structure, acquiring in this way a preliminary insight into the age of the district we were about to visit. After a brief, but agreeable, sojourn, we left that quaintly attractive city, Tiflis, in the evening, by special train, for Baku, and, on awakening in the morning, got the first indications of the great changes that awaited us. We were travelling northward instead of eastward; the river Kur, which we had hitherto followed, had disappeared from view; the mountains had dwindled into comparative insignificance; the fertile valleys had given place to barren plains; the trains of oxen ploughing were no longer to be seen, but were replaced by caravans of camels toiling slowly along; and frail carts on very high wheels took the place of the sturdy, stumpy vehicle of Tiflis and its neighbourhood. Such things as these, and an occasional village consisting of a small cluster of square, white, flat-roofed, squat houses, or, rather, huts, with curious domed chimneys, and the groups of queer-looking people about, kept my attention attracted; then the Caspian came into view, and finally a distant forest of derricks announced our proximity to the famous oil region. On arriving, we found we had covered the distance between Tiflis and Baku, 326 miles, in 15 hours.

The tour of inspection arranged included visits to refineries, to the Bili-Eibat oil field, to the Saboontchi, Balakhany, and Romany oil-fields, and to the Sourakhany district,—all on the Apsheron peninsula.

The city of Baku is the great centre for oil-refining and export; we had immediate evidence of the export trade in the multitude of long lines of tank-wagons accumulated in the extensive railway yard and in the numerous storage tanks visible in our immediate vicinity, while a short drive, bringing us in view of the Black and White Cities, revealed the industry itself. Here there was considerable evidence of oil-distilling on a large scale, evidence too that appealed to every human sense. Hissing, thudding, rippling sounds assailed the ear; stills, condensers, tanks, vats, pipes (of all sizes, in all directions, over head and along the ground), buildings of graduated height, mud, black mud, black iridescent puddles, chimneys, and steam obtruded themselves on the vision, when the eyes were not rendered useless by dust; then, too, everything reeked of oil and felt greasy; and not only was the sense of smell violently attacked, but the palate also had its quota of the peculiar attributes of the atmosphere. In spite of all these unattractive elements, the busy aspect of the scene was exhilarating, and the various distilling apparatus were keenly inspected. The agitation of the oil with acid to remove objectionable constituents was eagerly watched, in order to see the air injected at the bottom of the great vats and cause the desired turmoil, and then the similar treatment with alkali, to remove the acid, was looked into. We admired the placidness reigning in the settling-tanks, where the oil was separating from the water previous to transference to one of the many capacious storage-tanks for refined produce. Of the distilling appliances the continuous distillation plant is the most impressive. The oil enters the end still of a series of stills, and, flowing from one to another, is exposed in each to an increased temperature, nicely regulated by adjusting the supply of liquid fuel and air used for heating the stills. Ultimately the residue of the oil passes out at the last still. Each still is provided with its steam superheater and with its condenser, the steam superheater providing steam at the required temperature to aid the separation of the volatile portions in each separate still, the condenser furnishing the necessary cooling to bring these volatile portions to the liquid state. There are steam pipes, water pipes, oil pipes, and double valves to each, and then a valve at the lower part of each still for draining out residual oil, so that any one still can be isolated, drained, cleaned, or repaired, without stopping the others. After inspecting arrays of superheaters with the arrays of the more stalwart stills and condensers alongside, making great ugly avenues, and a veritable complexity of pipes and valves, it is a relief to see that it all comes right in the end. This is discovered on entering the receiving-house. There vast numbers of pipes converge, there the various distillates arrive at the end of their journey, there the various residues



GROSNY. OIL WELLS AND LAKE OF OIL.

are delivered, there the water from the condensers and the water that has become mingled with oil have to come. Each oil, or water, as the case may be, comes along, and from its own special pipe; and in this house each is directed in one of the many channels provided, which conducts it to its destination. Some products are mixed by directing them into the same channel; some are destined for further treatment by distillation; some for chemical treatment; some for the market. The distillations and the disposal of the products are well managed at Baku, and leave a very pleasant impression from a technical point of view. Baku mainly busies itself with the manufacture of four products,—kerosene, lubricating oils, benzine, and astatki. It exports these and some crude oil, leaving the purchaser to make the various modifications and admixtures required for the various petroleum preparations. We had an opportunity of examining the products in various stages, from the crude oil to the finished state. They were displayed for our benefit in glass jars, and greatly enhanced our appreciation of the advantages derived from the various treatments of the Baku oil, helping to explain to the uninitiated why the imposing sulphuric acid and alkali works were a desirable adjunct to the refineries.

In the whole district there are more than a hundred refineries, some treating crude oil for kerosene only, some treating crude oil for

kerosene and astatki for lubricating oils, some for lubricating oils only, some for benzine alone, some for benzine and lubricating oils, and some for distilling tar. Then, various stations for storing kerosene and astatki make up the complement of establishments. These establishments deal daily with about 28,000 tons of crude oil for kerosene, of which 3,750 tons is treated in some 370 intermittent stills, and 24,250 tons in some 450 continuous stills arranged in 67 batteries in 48 refineries. Some 160 intermittent stills deal in 24 hours with 1,610 tons of astatki for lubricating oils, and 700 tons of the same material is treated during the same period, for the same purpose, in 37 continuous stills arranged in three batteries; moreover, some 400 tons of gasoline are treated, in the day, in intermittent stills, for benzine, of which they yield 112 tons. Altogether, there are about 820 kerosene stills at work, with a possible maximum output of 9,510 tons of kerosene in 24 hours, or more than 3,200,000 tons a year, which, however, is not attained, as other appliances in the district are not equal to dealing with so great an amount. The appliances referred to are boilers and the various tanks and reservoirs for holding unrefined and refined products, for the treatment with acid and alkali, for settling, and for astatki. Yet the total number of these is prodigious, as may be gathered from the following table:

	Number.	Capacity in tons.
Tanks of all kinds for kerosene.....	953	429,225
“ “ “ “ “ lubricating oils... ..	560	44,445
“ “ “ “ “ benzine.....	116	24,104
“ “ “ “ “ astatki.....	344	2,988,523
Boilers.....	544	13,567 h. p.

The storage-capacity for refined products alone is as follows:

	For refined kerosene.	For refined lubricating oils.	For refined benzine.
Capacity of tanks in tons.....	307,968	20,328	1,159
Number of tanks.....	234	91	22

The yearly output from the refineries, in tons, is given below, together with the figures for ten and twenty years ago:

	Kerosene.	Lubricating oils.	Benzine.	Astatki.
1896.....	1,409,424	139,494	2,705	4,758,142
Ten years ago.....	720,000			
Twenty years ago....	97,550			

These figures do not include losses by waste and leakage; they show that the Baku petroleum industry is increasing, and, as a matter of fact, it would advance still further were there greater facilities for distribution; there are not sufficient tank wagons or pipe lines.

Of the output Nobels produce 286,205 tons of kerosene. No

other manufacturers approach them, the two firms next to them producing 96,000 tons each. It is noteworthy that 5,431,600 tons of crude oil were used in the production of the 1,409,424 tons of kerosene; that is, burning oil amounted to only 25.51 per cent. of the total produce, instead of 27 per cent. in 1895, 24 per cent. in 1894, and 30 per cent. or more in all previous years. As a matter of fact, the output of kerosene in Baku is diminishing, and that of *astatki* increasing; this is due to difficulties encountered in the disposal of kerosene, such as competition from other petroleum-producing countries, as well as the dues that have to be paid on kerosene in Russia itself, while no



AN OIL WELL AT GROSNY.

dues are enforced on *astatki*. Moreover, the use of the latter is being much extended in that country, and is highly appreciated as a fuel, as, in fact, it should be. The consequence is that the production of this commodity in Baku is strenuously forced by limiting distillation and by admixture of various intermittent oils, or even crude oil, with the actual residues,—practices that raise the yield of *astatki*, but at the expense of the quality, introducing properties undesirable in a liquid fuel. There is, however, a market for some of the heavier distillates, and therefore they continue to be produced and sold; thus the oils of a specific gravity of 0.860 to 0.890 become solar oil, and, when refined,

are used in lamps with special burners, and, in the unrefined state, as gas-enrichers. Then come the series of lubricating oils: spindle oil, with a specific gravity of 0.890 to 0.900, flashing at 150° Centigrade, or above; engine oil, with a specific gravity of 0.900 to 0.910, flashing at 180° or above; and cylinder oil, with a specific gravity above 0.910, flashing at 210° Centigrade. These bring fair prices, and as much as 144,000 tons of lubricating oil in a year have recently been produced from 17 refineries.

Last, but not least, a special word of gratification must be expressed in connection with the great and imposing pumping installations; it is really most attractive to see these busy assemblages of pumps of many types and varying sizes, dealing, as they do, with oils of all gravities, with water and with air, in millions of tons. One is not surprised to learn that there are 1,100 pumps at work in Baku. Many of the visitors became acquainted for the first time with the vast and interesting operations that the oil had brought into existence, and an inspection of the sources of this valuable material was consequently undertaken with considerable eagerness; for, in addition to this factor, there was a very interesting geological problem to investigate, of which, too, our Russian *confrères* had supplied a solution. We had satisfied ourselves as to the tenability of part of the solution offered, during our journey across the Caucasus, and by some special excursions in Trans-Caucasia, which put us in a position to accept many general statements that could not be verified by actual inspection during the limited time of our visit.

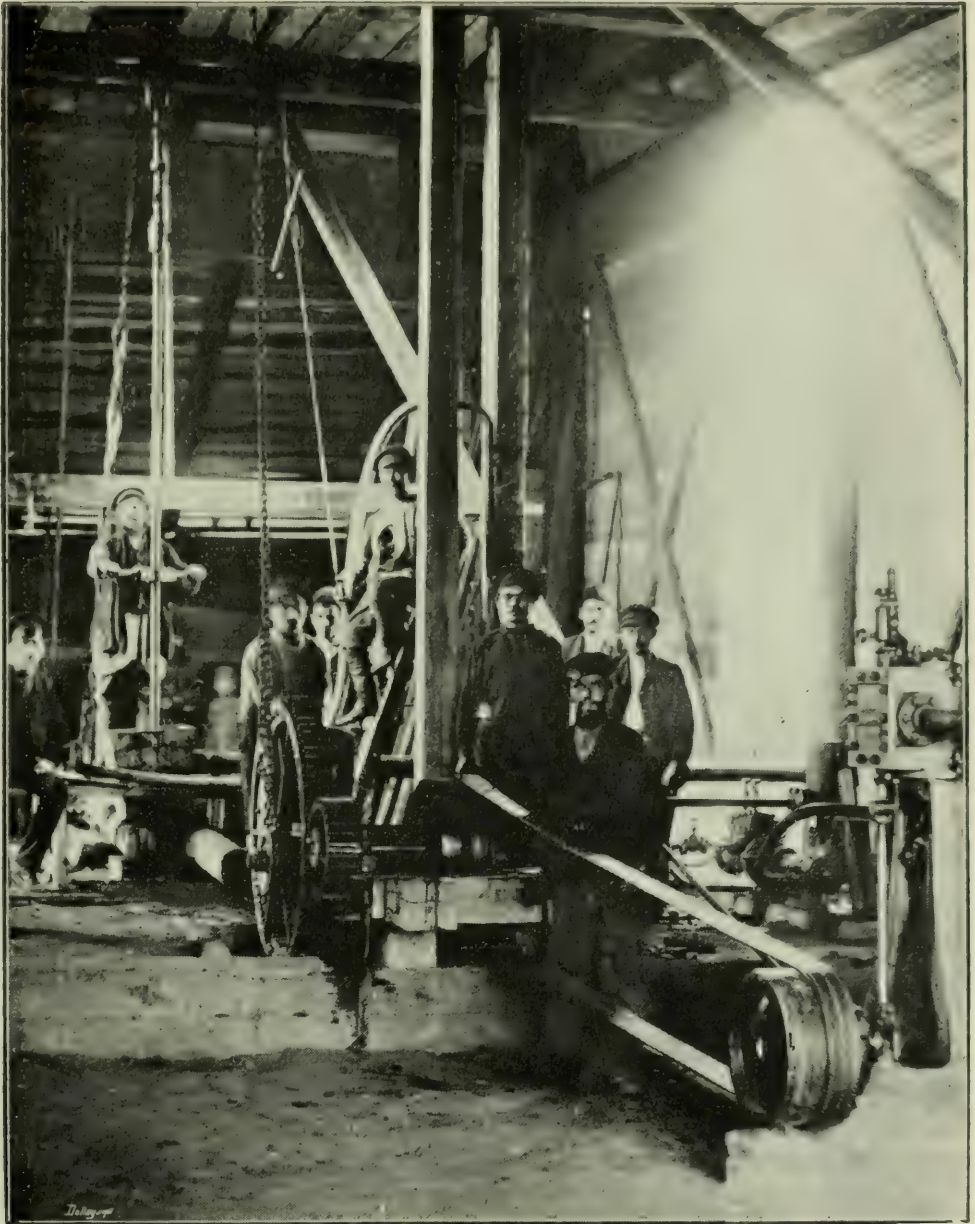
Our first visit was to Bili-Eibat. It lies in the same bay as Baku, and a little more than three miles south of that city. We reached it by boat, which gave us an opportunity of seeing the character of the surrounding country. The main feature is an escarpment trending southward, but taking a curved course, bearing south-east and terminating, as far as our field of vision extended, in a cape at the south-western extremity of the bay. On a promontory in the low-lying ground between this escarpment and the bay numerous derricks indicated what was going on. But, approaching from the sea, earlier evidence of the presence of oil-bearing strata below the surface of the Caspian sea was forthcoming in the form of briskly bubbling gases, giving the water the appearance of vigorous ebullition. There were several such centres, and, by throwing lighted tow into such a centre, ocular demonstration of the character of the gas was acquired. The faintly-luminous, flickering flames dancing about on the ruffled surface of the water presented a curious and weird appearance.

We were soon in a position to gather that the Bili-Eibat oil-field was situated at the summit of an anticlinal fold, evidently dipping

under the sea eastward, and very probably also northward and southward on the eastern side, while the whole of the western side, from north to south, is covered and encircled by the rocks and escarpment already referred to, which consists of a continuation of the Aralo-Caspian limestone upon which Baku itself is situated. Borings indicate that the strata forming the anticlinal consist of oligocene beds of oil-bearing sands over clayey beds, the oil-bearing sands coming to the surface at many points in the bay and below the surface of the water. The whole valley has been formed by the disruption and erosion of oligocene beds.

The winning of the oil was now to be investigated, and we were fortunate in being able to see all stages of progress, which at once showed us that Bili-Eibat was by no means an unpromising field. The boring derricks are of the usual kind, but are entirely covered in, and the building in which the engine is placed is continuous with the derrick. The boring is done with iron rods and a free-falling bit, the appliances being of the usual description, and we had the opportunity of witnessing the starting of a boring, the lining of a boring, the widening of a boring, the deepening of a boring, the lengthening of the rods, the changing of the bits, and even the recovery of a lost bit; and, I must say, the operations were conducted with expedition and much skill. In one case the casing tubes in the upper part of the well were 26 inches in diameter, were made of plates riveted from inside, and were to be continued to a depth of 200 feet. The ultimate boring was to be 1,400 feet, and would cost about £20 a fathom. In course of our progress, a spouting well was visited. It presented a striking and beautiful sight. The bright sunlight coming through the open door caught the ascending column, and made it shimmer and glitter in a dazzling manner, while the falling streams, drops, and spray glistened like so many rich-coloured gems. Then the whole was surrounded by a curious prismatic halo. This fountain came from a depth of 1,418 feet, and was giving 192 to 208 tons a day after 16 months' spouting. The oil from the wells flows away into open tanks made by digging out and tanking up the soil. A fountain produces more oil than can be dealt with, and much is lost by flowing away, and much by sinkage, although the tanks soon acquire an impervious coating of slime, and so retain the oil that flows into them. Another loss is by evaporation; this is sometimes so great, owing to long exposure in the case of fountain produce, that the oil ultimately is fit only for fuel oil, or masut, as this untreated oil is called. This is especially the case with Bili-Eibat oil, which is deficient in viscosity.

In most of the wells oil was being pumped, or, rather, wound,



BORING AN OIL WELL IN THE BAKU DISTRICT.

up, for the large proportion of sand that accompanies the Baku petroleum prevents the use of a pump. Therefore, the oil is drawn up in great buckets,—that is, in cylinders of a diameter suitable to the diameter of the well, and of any convenient length, fitted with a valve opening upwards in the bottom. This is run down into the oil, allowed to fill, and drawn up; then the oil is let out into a trough leading to the tank outside, and the operation repeated. The time occupied depends on the engine and depth of the well, and the quantity drawn each time depends on the capacity of the cylinder and the completeness



AN OPEN TANK, OR RESERVOIR, FOR OIL.

of the displacement of the air. Two minutes seemed a fair allowance of time from surface to surface, while the quantity drawn seemed to vary from 12 tons a day upwards. When there is water in the well, a cylinder of water is drawn periodically for this purpose. The cylinder is run to the bottom of the well, the valve opens, and the water displaces any oil that has entered the cylinder during the descent, the valve closing again when the cylinder is lifted. Recently Bili-Eibat has produced as much as 1,120,000 tons a year, of which 75 per cent., or 540,000 tons, came from fountains. The maximum yield in the year from any single fountain well was 392,000 tons from a depth of 1,358 feet. Bili-Eibat has more fountains than any of the other fields, and the average yield per well, about 32,000 tons, is higher. Moreover, it shows an increase, whereas the other fields show a decrease. The greatest average comes from wells from 1,260 to 1,330 feet deep. At the end of 1896 there were at Bili-Eibat 25 productive wells and 26 new borings; 2 wells were being deepened, and 1 was being repaired, and there were 4 new derricks and 15 unproductive wells. Of the Bili-Eibat oils part is refined on the spot, part is shipped to Black and White Cities, part is taken overland to Persia, and part by the Caspian sea and the Volga to the interior of Russia.

The next visit was to the north-east of Baku, to the three great



LATOUROFFS NO. 19 WELL AT BALAKHANY.

oil-fields of Balakhany, Sabountchi, and Romany. They form respectively the western, central, and eastern parts of an almost triangular area of land measuring about $4\frac{1}{2}$ square miles and representing the most productive oil area; but, inasmuch as the country for a con-



BUILDING THE DAM OF AN OIL RESERVOIR.

siderable distance outside this area is above the sea, conditions for studying the geology are excellent. Moreover, the great number of borings facilitate immensely the progress of this study. The result of this is a demonstration that the deposits are exactly similar to those already referred to at Bili-Eibat; moreover, they also form an anticlinal with the axis, inclining slightly from north-west to north-east and with gently sloping flanks. The oil-bearing beds, where they extend beyond the rich area, consequently sink deeper and deeper under the overlying Aralo-Caspian limestone, on the northern, eastern, and southern sides, in the rich area itself travelling from east to west. The overlying clays, the oil-bearing strata, and the underlying clays and eocene beds full of fish-remains come to the surface in succession; thus the oil-bearing strata are thrust out at the western side by non-productive beds, whereas on the eastern side the oil-bearing strata do not terminate, but simply get deeper. Evidence of this is afforded by an inspection of the Sourakhany district, where gas escapes in vast quantities from every fissure in the limestone. This, too, has been going on for centuries, as is testified by a very interesting and striking ancient temple of the fire-worshippers, where the natural gas maintained their perpetual fires. It was a source of regret to most of us to observe that



A BURNING WELL.

this remarkable relic of the past has not been treated with the respect it deserves, for in immediate proximity to it there has been erected a hideous refinery; one sighed for very much less refinery and a little more refinement. In this neighbourhood, too, the limestone is still burned to lime by simply heating it up, piling it over a fissure, and igniting the gas. When the burning is complete, the fire is smothered with earth, and the lime cleared away, and the operations are re-started on a new lot of broken limestone. But, returning westward, it is noteworthy that the character of the oil below the gas varies with

the strata in which it is found, being lightest in the uppermost and heaviest in the lowest. For instance, in the overlying clay oils of a specific gravity from 0.820 to 0.840 are found; the oils in the naphtha-bearing beds have a specific gravity of 0.865 to 0.875; while the underlying clays yield oils of a specific gravity of 0.885 to 0.920. Taking into consideration the deposits lower still, full of fish-remains, we find some support of considerations recently set forth by the writer.

The operations at these oil-fields are conducted in a manner similar to that followed at Bili-Eibat. That is, a covered derrick is erected; the boring is wide at the start and cased with wide tubing; as it descends, it narrows, and the oil is allowed to flow, or to spout, or to be pumped, and then collected in open tanks dug in the ground. It was here, on the property of the European Petroleum Company, that we saw an intermittent fountain. It was an absorbing spectacle to watch the pumping steadily progressing through the open door of the derrick, and then suddenly to see the bucket, on arriving at the surface, followed by a dark column suggestive of the rod of a hydraulic lift, which, however, almost instantaneously outran the pump and rose out of sight into the closed upper part of the derrick, to reappear immediately, partly as a cloud of spray projected from the top of the derrick to fall in a shower of chatoyant drops, partly as a glittering cascade formed by the oil pouring over the top and oozing out between the covering planks and rushing down outside the derrick, unmercifully drenching the men below and covering the ground for a distance round with sand and streams of oil. This performance was repeated two or three times an hour, and the well was yielding 640 to 800 tons a day from a depth of 1,195 feet.

The following data furnished by Mr. Leon, with the permission of the European Petroleum Company, show the working of these fields during 1896:

	Productive wells.	New Borings.	Deepenings.	In Repair.	New Derricks.
Balakhany.....	242	58	13	18	31
Sabountchy.....	246	78	22	39	20
Romany.....	69	26	7	10	15

	Non-productive wells.	Average produce per well. tons.	OUTPUT.		Percentage of total by fountain.
			Pumped. tons.	Fountain. tons.	
Balakhany.....	55	4,725	1,368,000	2,363	0.1
Sabountchy.....	91	5,920	2,217,600	225,872	9.1
Romany.....	9	14,880	918,400	330,464	26.1

In the Baku district borings have to go deeper and deeper; that is, the upper oil-bearing strata are becoming exhausted. The deepest well is about 1,750 feet. The largest average yield in Balakhany is 5,760 tons from a depth of 700 to 770 feet; in Sabountchy, 10,320 tons, from a depth of 980 to 1,050 feet; in Romany 22,624 tons, from a depth of 1,050 to 1,120 feet. The geological character of the ground accounts for these increases in depth, or, *vice versa*, the increase in depth has suggested the geological views entertained. Moreover, as the wells get more distant from the centre of the field, the water-bearing upper beds are encountered in the borings, and introduce an undesirable element, which, however, does not impede progress to a very great extent, as may be gathered from the following data, obtained at the time of my visit to Baku.

GENERAL STATISTICS OF THE BAKU PETROLEUM MINES.

	1890.	1891.	1892.	1893.	1894.	1895.	1896.	First 7 months of 1897.
Millions of tons of petroleum produced }	3 $\frac{2}{3}$	4 $\frac{2}{3}$	4 $\frac{2}{3}$	5 $\frac{1}{8}$	4 $\frac{3}{4}$	6	6 $\frac{1}{8}$	4
Thousands of feet bored. }	103 $\frac{2}{3}$	140	81 $\frac{7}{10}$	77	90	146	197	147

POSITION OF THE PETROLEUM MINES ON THE 1ST OF AUGUST, 1897.

Number of completed wells.....	917
of which there were (a) Productive.....	644
(b) Deepening.....	46
(c) In repair.....	47
(d) Being cleaned.....	5
(e) Idle.....	175
Wells in boring.....	295
Wells sunk since systematic working of the petroleum fields at Baku...	1,650
Area of petroleum fields in work, square miles.....	2.172
Number of firms engaged in the petroleum operations.....	97

It is strange to look back ten years and recall the rumours then in circulation that the Baku oil district was exhausted. It required the pen of the famous chemist, Professor Mendeleeff, to refute the statement. It has been my intention to set forth actual facts gathered, and impressions formed, during a recent personal inspection of the district, and to show how little changed, otherwise than in magnitude, the character and position of the Baku petroleum industry are, even after many years. It remains to add that we enjoyed unbounded hospitality during our stay in Baku, and that the European Petroleum Company not alone photographed us and presented us with copies of the photograph, but also kindly furnished data and illustrations.

EFFECTIVE SYSTEMS OF FINDING AND KEEP- ING SHOP COSTS.

By Henry Roland.

THE SPRAGUE ELECTRIC COMPANY'S METHODS.

TIME passes, and it works changes as it goes. Ten or eleven years ago Mr. Frank J. Sprague was fighting the battle of electric traction almost single-handed against the combined negative of all engineering authorities.

Time has passed since then, and has worked its changes. To-day one of the largest divisions of railway service has been delivered over to electric traction so completely that it stands as unquestioned practice. By another of time's changes electric street-railway traction, as exhibited in the trolley car, is no longer a matter of absorbing personal interest to Mr. Sprague, although some of his patented inventions still hold exclusive fields in street-car-motor construction. Vertical translation by electricity in the various forms shown by the Sprague elevator, electric motors, dynamos, fans, and conduit work are some of the constructions of the Sprague Electric Company, with offices at 20-22 Broad street, New York, and factories at Watsessing, New Jersey, and 527 W. 34th St., New York City.

Mr. Edward H. Johnson, Vice President and General Manager, is the chief executive officer, and to him is due the remarkably effective organization of service now in force. A distinguishing feature of this organization is the perfectly clear definition of the duties of each officer and employee, by which individual responsibilities are fixed beyond doubt or question. This highly important requisite of successful operation is due entirely to methods and allotments, many of them displaying the highest ingenuity and greatest discrimination, originated by Mr. Johnson.

The present Sprague Company is the legal successor of the Sprague Electric Elevator Company and the Interior Conduit and Insulation Company. It is capitalized at \$5,000,000, and employs more than a thousand men.

The Watsessing factory is among the finest American industrial structures, and its equipment is the best that American machine-tool makers can furnish.

Until recently the system of cost-keeping used at the Watsessing factory was perhaps the least satisfactory of its features, though possibly better than the systems used in many concerns of high repute. It was resolved to replace it with the best system that could be devised. This replacement has been effected, and the Sprague Company has

most courteously afforded me every facility for the preparation of a concise and detailed description of its more prominent labor saving and accuracy-securing devices, many of them entirely new and of the highest interest to all factory managers and accountants. It will be presented in two papers, of which this, the first, will be devoted to flat cost-finding and keeping, while the second, based upon the Sprague practice, will deal with the expense account, expense apportionment, and estimating.

The system of factory accounting now used by the Sprague Electric Company was installed by Mr. J. N. Gunn, of Boston, within the past year, and is comprehensive, including an absolutely complete record of all factory expenditure and performance, while at the same time it is cheap, entailing far less clerical labor than some systems which do not approach the Sprague results in completeness of detail.

This highly-desirable outcome is obtained, first, from a thorough comprehension of the broad problems of factory accounting, of course, but none the less from novel and, in many instances, highly-ingenious combinations which are neither more or less than original inventions, and which must be thought out in detail for each individual factory. No two manufactures are precisely similar, and, while the general scheme of accurate factory-accounting is unvarying, novel combinations and modifications can and must be made in each case, to bring the actual working details of the cost-keeping system into harmony with the inherent peculiarities of the individual concern. In other words, it is impossible to produce a cost-keeping system which shall be the very best for every factory.

This proposition should be fully comprehended. Many manufacturers who are aware that their own cost-keeping does not produce satisfactory results believe that there is such a thing as a universally-applicable system of factory accounting.

It is true that a system of factory accounts can easily be devised which will, if carried out in all its wearisome and costly multiplicity of detail, give a complete record of the performance of any factory as a whole and in detail; and it is these burdensome and practically impossible systems of universal application which are presented in the ponderous treatises on cost-keeping produced by accountants who were accountants simply and solely, and hence saw no impropriety in applying successful weaving-shed and spinning-room methods alike to the foundry, the machine shop, and the factory producing small metal wares, without any change of detail.

Not only are these universal systems cumbersome and costly, but they fail utterly to give directly those comparable totals that indicate changes conducive to shop economies; and it may be asserted, with-

out fear of contradiction, that the first requisite of an ideal cost-keeping system is that it shall force the instant recognition of cost-fluctuations, and the constant comparison of related cost-factors.

Accepting this, it becomes immediately evident that the best cost-keeping system for any one concern must be especially devised, and fitted to the particular manufacture carried on, and to the special conditions of trade environment under which the individual factory is doing business ; and that there cannot possibly be even a fairly good approach to the best results without specially-devised details exactly suited to the case in hand.

It is the purpose in these articles to avoid bald assertions, and to present intelligible records of actual practice ; but, believing that there is a common impression that a generally-applicable and altogether perfect cost-keeping system pursues its hidden and inevitably wealth-producing existence within the mahogany and plate-glass labyrinths of the offices of some of our great factories, it seems proper to assert that there is no such possibility. In point of fact, very few large establishments are satisfied with their factory-accounting systems, and many of these systems are highly-tedious and burdensome complications, non-homogeneous, without a central and dominating motive,—actually mere aggregations of makeshifts instead of wisely-devised unities.

The cost-keeping system which Mr. Gunn has introduced at the Sprague Electric Company's factory records everything on cards adapted to card index filing, and hence calls for no books or book-keeping whatever. The nearest approach to an account-book in the factory-cost-keeping proper is produced by filing some of the larger blanks in the "Tengwall" file and binder, made in all needful sizes, and holding from one to two thousand sheets securely in book form, any sheet being instantly removable without disturbing any other sheet. This use of cards, card system filing, and the Tengwall binder, saves the labor of transcription. All additions are made mechanically on a "Felt and Tarrant Comptometer,"—computing machine,—and by these aids the labor and opportunity of error are vastly reduced.

Too much cannot be said in favor of the "card system," as opposed to bound account-books of the ordinary form. There is no space here for enlargement on this important topic. It must suffice to say that all cost accounts can be kept by means of the card system in much more accessible form, and with vastly less labor, than by the use of bound volumes. Both index cards and boxes should be purchased of regular manufacturers, as their production requires great experience and costly special machinery to give satisfaction.

The business offices of the Sprague Electric Company are in the

INSTALLATION				GENERAL ORDER No. B		
Elevator No.	Draughting Room No.	Contract No.	Date			
Ship to Via Bill to Please deliver the following on or before						
Shipping Check	Date Shipped	Date Billed				
Quantity	DESCRIPTION	Shipped	How	Number	Charge	Price
THE SPRAGUE ELECTRIC CO., WATSESSING, N. J.						

FIG. A. OFFICE ORDER TO FACTORY; MANIFOLDED 5-FOLD.

Commercial Cable Building, New-York, and include the engineering department, where all work is designed, and the construction department, which installs the products of the factory. In addition, the New York office has charge of advertising, sales, travellers, and agents, and makes all orders to the factory.

The factory has a general manager, who exercises entire control. It is divided broadly into the production department—sub-divided into drawing room, pattern-shop and machine shop, electrical department, and so on—and the accounting department, where all the factory accounts are made up,—twenty-three departments in all. The factory does nothing except on order of the New York office or the general factory manager.

Factory orders are manifolded five-fold. Two copies are filed in the New York office, in the filing room, which is in charge of a chief and two assistants, whose sole duty is to file and keep all papers of every description relating to the business of the house, the system adopted being such that any paper required can be instantly produced or traced, as any document once delivered to the filing room is thenceforth receipted for, if removed. One copy of each work order is filed under consecutive number, and the other is filed in the individual customer's file-box. This makes it possible to instantly find the order either by its number or by the customer's name.

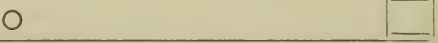
Production order No.	To Foreman	Date 189
Please execute the following order and charge all labor and material to the above order number.		
		
SPRAGUE ELECTRIC CO. (Factory System Form Or 1) General Factory Manager		

FIG. B. PRODUCTION ORDER; THICK AND THIN.

The production order is printed on one side only, in the form shown. It is $7\frac{13}{16}$ inches wide and $9\frac{13}{16}$ inches high.

Three of the five "manifolded" work orders go to the factory. Of these, one is delivered to the general manager, as head of the production department, one to the head cost-keeper, and one to the shipping clerk. If detail drawings are needed, they are ordered from the drawing room by the general manager. The chief cost clerk files his copy of the order in a Tengwall binder, where it is kept during the process of production. The general manager's order, after approval, goes to the "tracer," whose duty is to fix the date of shipment, which must be rigidly observed. The Tracer keeps his production orders in a filing box while current, and returns them to the accounting department when filled. The shipping clerk, on shipment of an order,

Sub. Prod. order No.	To Foreman	Date 189
Please execute the following order and charge all labor and material to the above order number.		
		
SPRAGUE ELECTRIC CO. (Factory System Form Or 2)		Foreman

FIG. C. SUB-PRODUCTION ORDER, THICK AND THIN.

makes triplicate manifolded shipping lists, one going to the New York office and one to the customer, while the third goes with the original order to the accounting department.

The "Tracer" is the unusual feature of this procedure, his work being done in other concerns by the Shipping Clerk or Shipping office. It will be observed also that the drawing room is relieved of all responsibility, except for drawings, as it has nothing to do with ordering either work or material into the shop.

Instead of signatures, or individual name or symbol stamps, those in responsible position use conductor's punches, each cutting a differently-shaped hole in the certified document, whatever it may be. This signature is always punched in the little enclosed square. The punch system has many advantages over the written or printed name or symbol. Many of the cards are printed in duplicate, both bearing the same number,—one on thick paper and the other on thin.

The factory manager may hold an office order at his discretion. When an order is accepted by the factory, the general manager issues "production orders" to the foremen of the proper departments, these production orders being manifold duplicates on thick and thin paper, gummed together at the left-hand narrow edge, so as to be readily separated after manifolding, and numbered consecutively in duplicate, as shown in Figure B. The size of this card is $3\frac{1}{8}$ by $4\frac{7}{8}$ inches.

The thin production order goes to the department foreman, and the thick one goes to the accounting department, where it is filed in a card system file while current, and when stamped "order completed" with date, is placed on permanent file, in a long index box.

In addition to the principal production order issued by the general manager only, sub-production orders may be issued by any holder of a principal production order. This reduces the manager's clerical work to the mere filling of the principal order, and enables the foreman addressed to obtain materials or labor from any other department, as he may require, in executing the principal order. The sub-production order, tinted robin's-egg blue, is shown in Figure C; it is in duplicate, size $4\frac{7}{8}$ inches by $3\frac{1}{8}$ inches. The thin card is held by the foreman addressed, and returned, stamped "order complete," to the accounting department. The thick sub-production order goes directly to the accounting department, and is filed with the principal order.

All stock and materials bought are ordered by the assistant purchasing agent from the "Foreman's Material Requisition," Fig. D, size $3\frac{1}{8} \times 5\frac{1}{8}$, on the purchasing order, Fig. E, size $7\frac{7}{8}$ by $4\frac{1}{8}$ inches, a manifold duplicate being sent to the purchasing agent in New York. The receiving clerk, who receives all material, has no

On Order No.	Department	Foreman 	Date 189
Quantity	Article		
○			
PUT ONLY ONE ENTRY ON A CARD.		MAKE ALL MEMO. ON THE BACK.	
SPRAGUE ELECTRIC CO., Foreman's Material Requisition. Fac. Syst. F. M 2.			

FIG. D. FOREMAN'S MATERIAL REQUISITION.
Made either on Rough Stores Keeper or Purchasing Agent.

notice of this order, and is therefore forced to make an original examination and report of every consignment of material received, on the "Materials Received" cards, Fig. F, size $5\frac{1}{8}$ by 4 inches, which go at once to the accounting department, and are checked with the invoice.

Fig. G shows the "Materials Returned" blank, size $4\frac{7}{8}$ by $3\frac{1}{8}$ inches, salmon tint, thin paper. This card is used for everything which comes into the shop, except new material. All material returned is immediately inspected, and its value credited to the proper account. It is punched by the foreman who receives the article.

Except rough castings, which are delivered on the shop floor, all

DUPLICATE.

Order No..... SPRAGUE ELECTRIC CO., Bloomfield, N. J.

To

Please send us the following goods to

Telegraph Address: Newark, N. J.

Send bills in duplicate. Terms 60 days. Via

Required by

For Order No..... SPRAGUE ELECTRIC CO.

..... Purchasing Agent.

Important. In referring to this order use number and put same on your bill—
this will facilitate payment.

FIG. E. PURCHASING ORDER; ISSUED BY PURCHASING AGENT ONLY.

Required For	Department	Foreman	Date	189
Quantity	Articles			
On Purc. Agt. Order	Remarks			
Received by		○		
PUT ONLY ONE ENTRY ON A CARD AND RETURN PROMPTLY TO OFFICE				
SPRAGUE ELECTRIC CO. Material Received Card Factory System, Form M 1.				

FIG. F. MATERIALS RECEIVED CARD.

new materials received go to the rough-stores room, under charge of a stores keeper, who keeps the stock up, and three assistants. Stock is checked out of the rough stores room on sub-production orders, which are immediately transmitted to the accounting department. All of these cards are placed in their appropriate files as soon as inspected by the chief accountant. They are brought in from the works by messengers, and there is no accumulation of them, as there would be if transcription were practised.

Fig. H shows the "Individual Factory Cost Record" made by the factory to the New York office ; size, $4\frac{7}{8}$ by $3\frac{1}{16}$ inches ; filed in New York Office, and available in estimating.

On Order No.	Department	Foreman	Date	189
Quantity	Article			
○				
PUT ONLY ONE ENTRY ON A CARD. MAKE ALL MEMO. ON THE BACK.				
SPRAGUE ELECTRIC CO. Foreman's Report Material Ret'd. Fac. Syst., Form M 3.				

FIG. G. MATERIALS RETURNED.

[illegible]

FIG. H. INDIVIDUAL FACTORY COST RECORD.

Fig. I shows the "Comparative Cost Card," giving successive costs of same article under the shop name, and indexed alphabetically. Size, $3\frac{7}{8}$ by $3\frac{1}{8}$ inches. These cards show at a glance whether the flat cost of any factory product is stationary, rising, or falling. This record is duplicated at the New York office and is used for estimating.

Each machine tool and each workman has an individual record in the accounting room.

Figs. K and K 1 show the front and back of the Individual Machine-Tool record. The front of the card gives particulars of purchase and durability; the back gives particulars of repairs and present condition of effectiveness. This card is obviously of the greatest

--	--	--	--	--	--	--	--	--	--

FIG. I. COMPARATIVE COST CARD.

value in determining subsequent factory equipment purchases. The back is filled in from the "Repair Cards," which are used both for shop repairs and for alterations or improvements in a previously-completed shop production.

Figs. L and L 1 show the front and back of the "Repair" order. This card issues only from the general manager.

Suggestions for repair or betterment are in order from any source—workman or foreman. These cards are thick and thin, in duplicate consecutive numbers, the thick one going direct to the accounting department, and the thin one being held by the foreman who executes the order, until sent to accounting department with the "order filled" stamp and foreman's punch, the total being charged to the "Plant and Betterment Account," credited in part to assets.

Rough castings are delivered directly to that part of the machine-shop floor most convenient to the machine tools by which they are to be finished. There are always exactly enough to fill the order, and no more. The receiving clerk's card goes immediately to the account-

Workman's Name	No.	Date
		189
Operation or Work		Foreman's Approval.
The rate given below has been agreed upon between the workman above named and the Sprague Electric Co , and will be retained until further notice.		
Rate	Per	For what order or part
\$		
O		
SPRAGUE ELECTRIC CO.		Piece Rate Agreement.

FIG. M. PIECE RATE CONTRACT.

Delays are dangerous, and nowhere more so than in matters of the counting-room. Records made by transcription are uncertain. Checking from one man's record to another is tedious, costly, and not infallible. All of these sources of errors are eliminated by the use of the index card, in manifold duplicate where the workman must hold a copy, so that every current item of indebtedness may be said to be actually posted in the final books of the accounting department, at the instant the indebtedness is created. Nothing is allowed to remain for a moment on the chief accountant's table, where all cards are delivered. The cards are placed at once where they belong, and the original accounting-room record is finished and done with, placed in its proper sequence, and indexed, instantly accessible forever, within a very short time after the account item is created. The value of promptness in business transactions cannot be overestimated, and Mr. Gunn's methods insure a promptness never before made possible in machine-shop cost-keeping.

The introduction of that unknown variable, the human element, of course brings trouble.

About 30 per cent. of the Sprague Factory workmen are on piece-rate. The remaining 70 per cent. are on day rates. The average hour rate of the factory is very high, being about 25 cents, with a considerable number of young hands in the winding and kindred de-

Name J. JONES.										No. 261	
Period	Date End'g		At Day Rate		At Pc. Rate		Hr. Av. Pc.	Gain		Loss	
1 Week	3	16	12	50	14	75	20	2	25		
1 Week	4	20	14	50	20	00	2.30	5	50		
Comparison of Earnings							○				

FIG. N. WORKMAN'S COMPARATIVE PIECE-RATE EARNINGS.
(Fill as filled.)

partments. A great portion of the work, however, demands excellent machinists, which accounts for the high average.

The piece-prices are based on an assumed individual workman's day-rate, which he may exceed by 25 per cent. before incurring the liability of "rate revision." Considerable latitude is given in the case of specialized laborers, low-rate men who have become experts in some single production ; and a piece-worker rated at \$2 per day, for instance, may go up to \$20 per week at piece-rates, before his reprehensible overproduction and product-cheapening is met by the penalty of a rate reduction.

The piece-rate contract is made in manifold, on thin and thick

Name			No.
Residence			Age
No.			
Date employed	Department or Operation	Rate per day	
Date transferred			
Date Emp. Ceased	Cause		
	Left-Discharged-Suspended		
○			

FIG. O. WORKMAN'S PERSONAL RECORD.

Man No.	Department	☐	Date
Foreman's Approval		☐	
Name			
Straight Time			
Over Time			
Extra over Time			
Charge to Order No.		Hours	Value
Charge to Order No.		Hours	Value

FIG. P. WORKMAN'S DAILY TIME CARD.

cards Fig. M, the workman holding the thin card, and the thick card going on file in the accounting department. The size is $4\frac{5}{8}$ by $2\frac{1}{8}$ inches.

The pale yellow card, shown in Fig. N, gives warning when a piece-rate workman is becoming too diligent and too expert, earning too big a weekly wage. As long as his pay stands steadily at about his permitted 25 per cent. advance over his assumed day rate, the piece-rate is not disturbed; but, when Mr. J. Jones has the temerity to reach a gain of \$5.50 in one week over his assumed day-rate, things must be seen to, promptly.

A third card relating to the workman solely is shown in Fig. O, called the "Workman's Personal Record." The size of this card is $4\frac{5}{8}$ by $2\frac{1}{8}$ inches, and it is filed in alphabetical order. The blank headings sufficiently indicate its character and uses.

The experience of the Sprague Company is against mechanical time-recorders. Men could not pass the one they now have, which is out of commission, fast enough. There are no gates, and no closed doors, and no watchmen. Each workman, on leaving the works at night, is given two similarly-numbered brass checks, marked A. M.

Article		Prod. Order		
		Date order completed		
		Actual cost		
		Estimate		
		Factory expense rate		
Cost of one only	Material	Dir. Labor	Factory Exp.	Total
TO COST DEPARTMENT.	SPRAGUE ELECTRIC CO.			

FIG. R. SUMMARY OF SINGLE PIECE COSTS.
Sent to cost estimating department, New York.

Sheet," shown in part in Fig. Q. This sheet may be of any size. That used is 10 inches by 24½ inches, punched at the left-hand end to go into the Tengwall binder, and ruled into four divisions by horizontal double lines, and filled with vertical dollars and cents columns, ⅝ of an inch wide. The Sprague Distribution Sheet has spaces sufficient to charge each of 68 different orders with 12 separate semi-weekly labor charges and 12 separate weekly material charges, with space for totals at the foot of each vertical column. The top line and middle line are for order numbers, and the top horizontal division is for semi-weekly labor charges; the next division is for weekly material charges, with the same order of numbers. The two lower divisions serve the same purpose for orders whose numbers appear in the middle line. The horizontal divisions are filled with semi-weekly totals, and the aggregate of the labor totals balances with the pay roll.

Fig. R shows the form of the cost summary card, size 5½ × 3½ inches, giving the total factory cost of a single article, great or small. The totals are made up from the Cost Record, Fig. H. This card goes on file in the estimating department.

REVIEW^{OF} THE ENGINEERING PRESS

A Year's Progress in Engineering.

AT the recent convention of the American Society of Civil Engineers, the president, Mr. Alphonse Fteley, delivered as his annual address a comprehensive review of engineering progress during the past year. Although it is impossible, within the limited space here available, to give even a close abstract of this excellent account of a year's progress in civil engineering, some points of Mr. Fteley's address may at least be noted.

Railway construction and operation are passed over lightly, the recovery from the set-back of 1893 not having been sufficiently marked to render this branch of engineering noteworthy; but the phenomenal development of electric railways continues. The advent of the trolley car has revolutionized travel, and affected the movement of population in the neighborhood of large centres.

The most important questions in connection with canal construction are those of a connection between the Great Lakes and the Atlantic, and of a waterway through the isthmus. The former is under investigation by a United States commission, and the latter has been revived as a consequence of the war between Spain and the United States. Both the Nicaragua and the Panama schemes are under investigation, the former by an American and the latter by a French commission, and from present indications it appears that the government of the United States may undertake the work as a national project.

In bridge construction the development of large spans has proceeded. The United States government has required the building of bridges up to 1,000 feet span over the Ohio, Mississippi, and other rivers. The necessities of traffic in New York city have given renewed impetus to the designing of suspension bridges of unprecedented span, and have caused the introduction of novel details, made practicable

by recent improvements in the manufacture of steel.

The recent reconstruction of the bridges at Niagara has shown the possibilities of steel arch construction, and the various designs for a suspension bridge over the Hudson river have carried the possibilities of bridge-building much beyond long-accepted limits. In this connection also must be noted the tendency to return to the construction of stone arch bridges, wherever local conditions as to cost of foundation and length of span have justified the generally larger outlay necessitated by this class of more permanent structures.

The modern tall building, with its steel skeleton structure, and deep foundations, has continued to find favor. Many new problems as to the stability and fire-resisting properties of such buildings have presented themselves, but the complicated questions of their equipment, including untried methods of carrying passengers and of supplying water, sewerage, heating, ventilation, etc., appear to have been solved satisfactorily.

In connection with water-supply are to be noted the following points: the extravagant consumption, or, rather, waste, appears to increase as increased provision is made to meet it, and, unless some more rational method than that now in use be employed to regulate consumption, it will be impossible to make reasonable provision to meet it. With the increased demand for water come also further requirements as to its purity. Filtration processes have been installed, and their action studied, and much valuable information has been gathered. Radical chemical and biological changes have been found to take place in the operation of filtering, and bacterial life has been recognized as the most potent instrument for the conversion of organic matters into mineral compounds.

Sanitary engineering is so closely allied

to water-supply that it should be considered in almost the same connection. The necessity for the final discharge of sewage into streams which may subsequently be used for water-supply renders the application of means for rendering the sewage innocuous a necessity. Sewage irrigation, filtration, and chemical precipitation have all been applied, both in the United States and in Europe, and much progress has recently been made in this important branch of engineering science.

In many branches of engineering valuable researches have been made, among which may be noted the experiments of the Massachusetts State Board of Health, which have contributed so much to the development of sanitary science; also the systematization of the tests of materials under the auspices of the International Association for testing materials; while the work of the forestry division of the United States department of agriculture has contributed greatly to our knowledge of timber physics.

In all this and much other work the professional standing of the engineer has been advanced, and his position as an eminent member of the community emphasized. The comparative youth of the engineering profession as compared with the professions commonly called learned has often caused it to be passed over by those who have failed to appreciate the importance of its work. With the increasing prominence of engineering work in everyday life, however, the standing of the engineer is becoming more fully recognized, and a continual gain in this respect is evident.

Portland Cement.

ALTHOUGH Portland cement is a very well-known trade article, there has probably nowhere been given so exhaustive an historical and technical description of its manufacture in various parts of the world as is contained in a paper read before the Civil Engineers' Club of Cleveland by Mr. Bernard L. Green, and published in the *Journal of the Association of Engineering Societies*.

After noticing the discovery of the

principle involved in the use of hydraulic cements by Smeaton, in connection with the construction of the Eddystone Lighthouse, the patent of Aspdin, and the arbitrary selection by him of the name "Portland," are referred to, the name having been selected on account of the resemblance in point of color and texture to the oolitic limestone of the island of Portland, well-known and in great favor as a building stone.

"Portland cement is produced from the intimate mixture of lime and clay, burned to a point just short of vitrification, and ground to a fine powder. It is thus essentially an artificial product and clearly distinguishable from the natural cements. It can be made from any materials having the necessary ingredients in the proper proportions, and these proportions may vary between narrow limits, depending somewhat upon the method of manufacture.

"Scientists have now proved almost conclusively just what chemical combinations and reactions take place upon the calcining of raw materials, and also when the cement is mixed with water and allowed to set. So there is nothing in the fundamental principles of Portland cement-making in which one manufacturer can claim superiority over his rivals; no secret processes, no patented methods; and his only chances to win the race of keen competition lie in natural advantages of raw material, location of plant, cost of fuel, choice of mechanical appliances, and price of labor."

Mr. Green gives an elaborate comparative review of the Portland cement industry in various countries, beginning with England, and including France, Germany, Belgium, and other countries of Europe, and devotes the conclusion of the paper to the American cement industry, with especial reference to its recent development. Since 1891 the proportion of manufactured to imported cements in the United States has been rapidly increasing, and, as more attention is paid to testing and investigating the various products instead of depending merely upon manufacturers' names and past reputations, the

local product has rapidly gained in use.

At the present time Germany is the greatest producer of Portland cement, 38.4 per cent. of the total output being from that country, while England, formerly in the lead, now holds second place, with 23.7 per cent., after which come France, with only 8.6 per cent., and the United States, with 6.6 per cent.

The demand for Portland cement the world over is rapidly increasing. In all the principal producing countries the factories are overstocked with orders, and hardly know how to fill them. European makers are not seeking the American market so anxiously, partly on this account and partly because they have to meet fierce competition from the American factories. Practically all the American product is used at home, while that of England and Germany is largely exported. The American establishments now supply about one-half of the domestic consumption, but at the present rate of increase it seems probable that the foreign brands will before long be almost entirely supplanted by the American cements, and that they may even attempt to seek foreign markets as well.

Electrical Vision.

THERE has been much talk recently about the alleged discovery of the Polish inventor Szczepanik in the line of vision at a distance, and the "teleelectroscope," as the apparatus has been called, bids fair to be the next object of scientific and popular interest.

Although no full disclosure has as yet been made of the method used in the new apparatus, an article on the general subject of electrical vision, in a recent issue of the *Scientific American Supplement*, gives the present state of public information upon the subject, together with as much as is known upon the subject of Szczepanik's invention.

The fundamental principle of the apparatus, as might have been expected, is the variation in the electrical conductivity of selenium, under the action of varying light. The simplest demonstration of this property is that of including a selenium

"cell" in a telephone circuit, causing a sharp click to be heard in the telephonereceiver every time a bright ray of light is allowed to fall upon the selenium.

"The discovery of Szczepanik, in brief consists in allowing the rays emanating from the object to fall upon a cell of selenium. Electric impulses will be produced in the selenium, whose intensity depends upon the brightness of the rays falling upon the cell. These impulses, being conducted to a distant receiving station, are there transformed again into light. The rays which fall upon the selenium are first separated into points of light by oscillating mirrors in the transmitting station. Similar mirrors in the receiving station vibrate synchronously with the mirrors of the transmitting station, and reproduce the image of the object."

"The retina of the human eye possesses the peculiarity of being sensitive to a light impression, even after the source of light has been extinguished, and for this reason it is that the unusually rapid vibrations of the mirrors are perceived simultaneously, and produce an image which is the exact representation of that transmitted from the first station. We have all seen how a spark on the end of a match, when rapidly swung around in a circle, produces the impression of a ring of light. In an exactly similar manner, the rapidly-succeeding points of light falling from the object upon the mirrors apparently produce an image of the original object. The question then naturally arises: Is it possible to oscillate the mirrors with sufficient rapidity to produce a series of points which, following one another with such rapidity, will cause a picture of the object to be produced."

The mirrors are arranged in pairs at right angles as regards their vibrations, and hence the number of points projected on the selenium in the transmitter will be equal to the product of the number of oscillations performed by each of them. If, for example, each mirror swings on its axis only 100 times in a second, then 10,000 points of light will in a like period fall upon the selenium, and be transmitted. As a matter of fact, the image points may

number hundreds of thousands, or even millions. So rapid are the oscillations of the mirrors that the tenth part of a second is sufficient to analyze the image of an object in the transmitter, and to render it visible at the receiving station. It is therefore possible to transmit a continuous action, such as a theatre performance, over the wires of the teleelectroscope, since the pictures received follow one another so rapidly as to produce the impression of a moving image, just as the numerous separate pictures of a chronophotographic apparatus reproduce past actions."

In the article referred to diagrams are given which are supposed to show the arrangement of Szczepanik's apparatus, but it is announced that the full details of its construction and operation are not to be divulged until it has been exhibited at the Paris exposition in 1900.

The Thermo pile as a Fog Signal.

NUMEROUS disasters at sea have shown that the most dangerous element in modern transatlantic navigation is fog, not only because of the obstruction to visual lookouts and signals, but because the only substitute hitherto used as a substitute for sight—*viz.*, sound—has proved both insufficient and deceptive.

Very recently a suggestion has been made by Mr. Hermann Herberts, in a communication to the *Electrical Engineer*, to substitute the very delicate thermo-electric pile for the siren, eophone, and other acoustic devices, and to attempt to determine the presence of approaching objects by differences of temperature.

It is well known that any object, when its temperature is higher or lower than that of the atmosphere surrounding the same, will either send forth heat radiations, or else, in the other case, absorb heat from its surrounding medium.

If we can construct an apparatus which is acted upon by such heat radiations, and if the apparatus be so sensitive that it will indicate the radiations, even if they be exceedingly weak, then we have a means which may be advantageously employed in navigation. As soon as we can inter-

cept the radiations sent forth from a vessel, we need not depend upon our eye or ear to locate the same. A modification of the thermo-pile or the radiophone may be employed in connection with this problem.

The apparatus, as now suggested, consists of two thermo-piles attached to a vertical spindle, so arranged that they can be rotated slowly, and thus exposed to radiations coming from any direction. A galvanometer enables any variation in current to be seen, and a connection with a bell gives also audible warning. Under these conditions the approach of any warmer body, as a steamship, or any colder body, as an iceberg, will have sufficient effect upon the thermo-piles, even at a considerable distance, to enable precautions against collision to be taken. By observations upon the position of the piles, and upon the increasing or diminishing effect of the radiations, the location and direction of motion of the vessel may be determined, and, as these effects are independent of atmospheric conditions, experiments conducted in clear weather can be used to calibrate instruments to be used afterwards in fog.

A number of details about the proposed apparatus are shown in the communication above referred to, and doubtless modifications may need to be made as a result of experience, but the method certainly offers possibilities not existing in the present ineffective fog-signal methods, and deserves to be submitted to every practical test necessary for its complete demonstration.

The Transmission of Power.

THE transmission of power from the point of generation to the point of application forms so important a feature in nearly all manufacturing establishments that it is always a fertile theme for discussion.

A general topical discussion upon this subject was held recently by the Western Society of Engineers, and from the report in the *Journal* of the society some interesting details are taken.

The discussion was divided into three parts, considering respectively the electri-

cal, pneumatic, and mechanical methods of transmission; the latter title being intended to include shafting, belting, ropes, and similar devices.

Taking first into consideration the use of electricity, as available for power-transmission in a factory, there seemed to be little doubt as to its convenience and advantage. Even for driving heavy machinery, the electric motor has shown its capacity, and the statements of Professor Jackson, and also of Mr. E. B. Clark, of the Illinois Steel Company, demonstrated the entire applicability of electricity for heavy rolling-mill work.

For general purposes electricity will probably cost more than shafts and belts, or shafts and ropes, but for many special purposes the first cost of electricity is no greater than the first cost of other transmitting agents which will do the work. There are many places in which shafts and belts, or shafts and ropes, cannot serve satisfactorily. In the latter places electricity has often displaced other means of transmission; and there are now numerous manufacturing establishments in the United States, which turn out a heavy or bulky product, in each of which considerably more than one thousand h. p. of electric motors are in use, driving general machinery. There are some plants which individually use more than two thousand h. p. in electric motors. In these cases the electrical machines have almost invariably replaced the older methods of transmission with success and advantage, as is shown by the fact that electrical transmission is being increased in magnitude in almost every one of these plants.

In summing up this question, Professor Jackson says:

"In constructing new manufacturing plants, the extra cost of a complete system of electrical transmission for the works is negligible (except under peculiar circumstances), compared with the annual savings effected by its means when its advantages are properly utilized.

"In certain industries the advantages of electrical transmission outweigh the first cost of making a change from mechanical to electrical transmission in established

plants, while in many plants where this condition would not commonly exist the arrangement of the buildings or the growth of the plant is frequently of a character, with reference to the prime power plant, which places electrical transmission upon an advantageous footing, either as an auxiliary to the main transmission or as a rival to the existing mechanical transmission."

Passing now to the use of compressed air as a means of transmitting power, its availability appears to lie rather in the special work for which it is adapted than to the general transmission plant.

The extending use of pneumatic tools for chipping, caulking, riveting, etc., together with the convenient forms of pneumatic lifts, blowers, and cleaning devices, all make compressed air a most convenient medium of power-transmission in many establishments.

In some instances air is the only medium which can be used, and the enormous capacity of the pneumatic painting device, as used in painting cars, is an example of the manner in which labor may be saved, one man doing the work of ten with this device alone.

Compressed air appears to be especially applicable for intermittent work, and in this respect it has the great advantage that it does not require the continual operation of the compressor, unless the demand is great. When the storage is not being drawn upon, the plant can be shut down absolutely, the reservoir with the power remaining at hand for use. This is of great advantage in a place where but a small amount of compressed air is used occasionally. In such instances a few hours' work of the compressor will compress all the air necessary, and the inconvenience and expense of continuous running are avoided.

In the face of the advantages shown by electricity and compressed air, it almost seems as if shafting, belting, ropes, and pulleys would soon be relegated to the past.

For extended transmissions this is undoubtedly the case. Engineers have realized for a long time that the power con-

sumed in transmission formed a large percentage of the total, even in the best-arranged establishments. In the discussion above referred to, Mr. H. J. Westover showed from actual tests that the ratio of the useful load to the full load in a number of establishments ranged from a little more than 60 per cent. to a little less than 30 per cent., and it is undoubtedly true that in most cases more than one-half of the power generated is consumed in overcoming the transmission resistance.

For many limited purposes, however, shafting and belting, or other mechanical appliances, will doubtless continue to be used. The manufacturing establishment of the near future will probably use all three methods in proportions varying with the nature of the work.

Primarily, all the power of the engines will be converted into electricity, and, as such, transmitted to the various parts of the establishment, to be used either directly or indirectly. Many heavy machines will be provided with their own motors, and probably the greater part of the current will be thus used. In some cases "group"-driving will be found more advantageous, and short lengths of shafting operated by electric motors will distribute the power by belts or ropes. When, in addition to this, we have an air compressor, conveniently operated by a motor, to supply compressed air to the special tools requiring it, we have a power plant at once convenient, flexible, and economical, and in nearly every case superior to any one of the three systems used alone.

Pneumatic Dispatch Tubes.

THE development of pneumatic dispatch tubes, especially for the local handling of mail matter, forms the subject of a paper by Mr. B. C. Batcheller, read before the Franklin Institute, and published in the *Journal* of the Institute. As the author has been closely identified with the subject in the United States, he is entitled to speak with the confidence which comes only from experience.

Pneumatic tubes of moderate diameter have been used for a number of years, especially for the transmission of messages.

London, Paris, Berlin, and Vienna for years have had their pneumatic-tube systems for transmitting telegrams between the central and branch offices.

There has been much misconception of the size, capacity, length, and use of the tube systems of Europe, and Mr. Batcheller states that the largest tubes used in London are only 3 inches in diameter, while those of Paris and Berlin are about $2\frac{1}{4}$ inches. No mail is sent through these tubes, as they are not large enough for the purpose; they are used only for the transmission of telegrams and messages.

The United States was much behind the various countries of Europe, in point of time, in the use of pneumatic tubes, but, almost from the start, undertook operations on a much larger scale.

The first tubes, 6 inches in diameter, were laid in Philadelphia for the dispatch of mail matter from the sub-station post office in the Bourse to the main post office, a distance of about 3,000 feet. Several difficulties present themselves in connection with the large carriers required for mail matter; such as friction, due to the increased weight, and the inertia, requiring provision to be made for the stored energy in the carrier in bringing it to rest. These have been successfully overcome in practice, and the Philadelphia tube has been in satisfactory operation for more than five years, and is still in daily use. The system involves a double line of tubes, the air flowing continuously through one tube and returning through the other, the return end connecting with the suction of the compressor. The arrangement is a pressure system, a pressure of about 7 pounds per square inch being employed.

Since the introduction of the Philadelphia plant several extensions of it have been made, and in New York an 8-inch system has been installed with success, and a similar one since in Boston. The 8-inch carrier used in these tubes weighs $13\frac{3}{4}$ pounds, and will carry 600 ordinary letters. Many interesting details have been evolved in the practical development of the system, and the arrangement of the sending and receiving apparatus is well illustrated and described in the paper.

The Niagara Hydraulic Power Plant.

So much has been said and written about the harnessing of Niagara by the great work of the Cataract Construction Company, with its shaft, tunnel, and Swiss turbine, that it is worth while to take a look at another power installation which derives its energy from the great cataract in a much simpler and, to many minds, more practical manner.

The Niagara Falls Hydraulic Power and Manufacturing Company, whose plant is described and illustrated in a recent issue of the *Electrical Engineer*, obtains its supply of water from the old hydraulic canal, constructed many years ago, which conveys water from the Niagara river above the Falls, through the city, to the brink of the gorge below the great cataract. For a long time the water from this canal was most imperfectly utilized by a number of mills along the edge of the gorge, only a small fraction of the possible fall being used, and the wasted water being allowed to expend its energy in miniature cataracts falling down to the rapids below.

In order to utilize the entire fall of 214 feet, from the level of the canal to the lower rapids, the Hydraulic Power Company has built its power-house in the gorge close to the lower level, and carries the water through two huge steel penstocks from the upper level to the wheels.

This arrangement entirely avoids the necessity of using the heavy vertical shafts which form so important a feature of the Cataract Company's plant, the generators being placed in the power house at the foot of the gorge and the energy conveyed to the upper level in the form of electric current.

The turbines of the Jonval-Geyelin type, were designed by the veteran hydraulic engineer, M. Emile Geyelin, of Philadelphia, and constructed by Messrs. R. D. Wood & Co. They are of the horizontal type the water being admitted between two wheels on the same axis and discharged on each side, draft tubes being provided in order to enable the total head to be utilized down to the level of the tail race. The armatures of the generators are placed directly upon the horizontal turbine

shafts, and the whole plant is characterized by a direct and straightforward simplicity which appeals in a peculiar manner to the engineer.

During the recent convention of the American Society of Mechanical Engineers at Niagara Falls abundant opportunity was given to the members to inspect both this and the plant of the Cataract Company above the Falls, and it was most interesting to observe the manner in which the two installations were viewed by these observant and competent critics.

The great shaft, tunnel, and generators above the falls were admired on all hands, and the skill with which the many difficulties had been overcome was praised. When, however, the unpretentious power-house in the gorge was visited, and it was seen how difficulties had been avoided rather than forced, and how, at a fraction of the cost, fully as much power was rendered available as at the world-famed plant above, there was nothing but admiration for the skilful manner in which existing facilities had been seized and a great plant created at a comparatively insignificant cost. It was a lesson which many were not slow to grasp, and which was repeated again and again during those few days.

An interesting feature of this plant is the use of aluminum conductors to convey the electric current from the generators in the power-house to the distribution. More than 22,000 pounds of aluminum are used in this installation, and, although a greater section is necessary than for copper, yet, weight for weight, the conductivity is double that of copper.

The work at the Niagara Falls Hydraulic Power and Manufacturing Company's plant has all been done under the skilful supervision of Wallace C. Johnson, and reflects the utmost credit upon his judgment and ability as an engineer.

Power from Producer Gas.

In advocating the use of gas engines we have frequently referred to the various methods of generating producer gas, and especially called attention of late to the applicability of blast-furnace gases for this

purpose. At the present time there are several excellent forms of gas producers,—or *gazogenes*, as the French call them,—which are well adapted for use with gas engines. In describing the results of some tests upon such apparatus, in an article in the *American Machinist*, Mr. W. H. Booth brings out some interesting features. The sources of loss in using producer gas in a gas engine are principally the radiation of heat from the producer, and the loss of the heat carried away in the jacket water of the cylinder and with the exhaust. It is practically impossible to prevent these losses, so far as the producer and the engine are concerned. If the cylinder was not provided with a water jacket, it would soon become too hot to work, the piston would seize, and the cylinder would become red-hot from the successive explosions; while the high temperature of combustion which makes the efficiency what it is necessitates a high temperature of exhaust.

In one of the cases referred to by Mr. Booth, however, the circulating water in the cylinder jacket was found just the thing for use in the dye-house, while the hot exhaust was used both for drying and also for heating the blast for the gas producer; thus these usual sources of loss were utilized in a very effective manner.

Mr. Booth makes out some very strong points for the gas engine and producer as a power-generating plant, when intelligently managed.

"Even at its worst, throwing away all the jacket heat, a gas engine is a much more efficient heat engine than a steam engine. By means of the gas producer it is able to use coal of a very low quality. Common gas coke, dirty slack coal, peat, and almost any combustible, especially if mixed suitably, will produce gas fit for a gas engine."

"It seems very certain that the gas en-

gine is destined, in conjunction with the gas producer, to play a large part in future motive-power production. We need not shut our eyes to the manifold disadvantages of the gas engine to be assured of this. Indeed, if we recognize these disadvantages, the more we must admit how much the gas engine has already overcome, and what a field there is for its improvement."

Until recently gas engines have been used only in moderate sizes, but the growing interest in the subject has caused builders to turn their attention to engines of large size, and now a number of gas engines of more than 200 h. p. are in use.

Mr. Booth gives some interesting figures of a large engine in use at Birstall, Scotland, operated by producer gas, which are of value as showing the general performance which may be expected. The gas, which was made from coal and coke mixed, contained about 25 per cent. of carbon monoxide, from 6 to 7 per cent., of hydrogen, and 1 to 2 per cent. of methane. Using this mixture in a gas engine, with a compression of 80 pounds per square inch, an initial cylinder pressure of 208 pounds was obtained, and a mean effective pressure of 88 pounds per square inch. The power developed ranged from 100 to 150 h. p., with a gas consumption of 97.5 cubic feet per h. p. It is estimated that the fuel cost per h. p. is only $1\frac{1}{8}$ pounds per hour, using low-grade slack mixed with coke.

While there are at present various objections to the use of gas engines, none of these can for a moment be admitted to overbalance the superior economy of this form of motor over the steam engine. Instead of finding fault with the weak points of the gas engine, its good features are so strong that we should encourage our ablest engineers to overcome all objections to the use of so economical and valuable a source of power.

THE BRITISH PRESS

The Launch of the *Amphitrite*.

THE enormous extent of England's naval construction is suggested by the quiet with which the many important launchings of the summer have been regarded. Events which would stir a smaller naval power through and through have been accepted as incidents, merely, in a programme whose magnitude would startle any other nation of the eastern hemisphere or the western, but which is yet regarded as inadequate by some critics.

And naval construction, after all, is but one element in an industry by which "the sea is England's glory" in the sense that her shipbuilders, no less than her sailors, have taken a leading part in making it the safe and busy high road of the world.

It is, therefore, interesting to notice the indications afforded by these latest incidents of the *rapprochement* of the mercantile and naval schools of marine engineering and architecture. Those who witnessed the magnificently-successful launch of the *Amphitrite* at the works of Messrs. Vickers, Sons and Maxim, Barrow-in-Furness, and had an opportunity to study her lines and her queenly appearance when afloat, were quite prepared, first, for Sir William White's statement that, in his estimation, she is his most satisfactory ship, and, second, for his comment upon the return to the graceful and beautiful lines which, at one time, seemed to have disappeared from naval construction. The warship of (say) twenty years ago was perhaps a thing of terror, but certainly not a thing of beauty. The tendency to ugliness rapidly reached a maximum after the complete discarding of sails, with the resultant creation of fighting vessels whose very appearance was a nightmare and gave rise to much of the impression that steam had driven beauty and romance from the sea.

The later and saner reaction, made strikingly apparent in the *Amphitrite*,

and, as Mr. H. W. Wilson has recently remarked in these pages, in all Sir William White's ships, is based upon appreciation of the fact that naval effectiveness depends, after all, upon stability, seaworthiness, and (as Mr. W. Laird Clowes so ably argued in *THE ENGINEERING MAGAZINE* for July) speed. These are distinctly engineering propositions, which the evolution of centuries has shown to be associated with graceful lines above and below the water. Of course, here or elsewhere, custom and convention may have much to do with our standards of beauty, and, if so, we may ere long learn to miss less the tall spars and sails of the frigate, and find a similar satisfaction in the contemplation of the modern superstructure.

The warship presents many grave and difficult problems which the naval designer must face; with the disappearance, however, of the idea that she must therefore be a circular tank or a huge, misshapen pontoon, the arts of the merchant shipbuilder and the naval constructor grow profitably closer together, and opportunity opens for most advantageous coöperation of marine engineers in both branches.

Sir William's "crawling cruisers"—crawling, as he humorously suggested at Barrow, at the rather un-snail-like pace of 20 knots—are exponents of an era; the esthetic characteristics, to which he called attention, are indicative of important underlying mechanical and economic conditions.

Safety at Sea.

IN view of recent disasters at sea, the ever-recurring question of the best methods of protection is again being agitated. Unfortunately, the greatest sources of danger are those against which as yet no adequate defence has been devised, but there are at least certain precautions which may be taken.

A recent editorial in *Engineering* reviews the most important precautions to

be taken by vessels crossing the Atlantic, and some of the points made cannot fail to be of interest at the present time.

"The chief danger that has to be faced by those making voyages in well-appointed steamers is collision; if we add strandings, we almost fill the list. The steam engine has made navigation independent of the direction of the wind, and the size of modern vessels, combined with the use of steel as a material of construction, enables the modern ocean liner to pursue its course safely through the heaviest storms. We have, of course, occasional break-downs of machinery, notably of propeller shafts. These correspond to the old carrying-away of sails and spars; but, whereas the integrity of the rigging of a sailing ship was a constant source of anxiety in heavy weather, engines work through calm or storm indifferently, so long as racing is prevented." Fog increases the danger of collision, and it is against fog that the greatest precautions need be taken. Masters of vessels are instructed to slacken speed in thick weather, but the slackened speed of a record-breaker is scarcely less than the full speed of an ordinary liner, and every captain knows that he is expected to keep time, fog or no fog; the passengers themselves would be among the first to complain, if the voyage appeared to be unduly prolonged. Besides, the plausible argument is made that, the higher the speed, the sooner the fog-area is crossed. The speed makes but little difference in the damage, if the ship is fairly struck, and, the sooner the fog belt is past, the sooner the danger is over.

The great objection to speed in a fog lies in the difficulty of hearing and judging relative positions; there is undoubtedly a better chance of being heard when going at a slow speed than when making eighteen or twenty knots.

The latter speed means that a nautical mile is covered every three minutes, and, although a foghorn may be heard a mile distant, it is very difficult to judge of the direction from which the sound comes until it is near. The result is that the location of the source of danger is often out of the question, until it is too late to

avoid a collision, or, if actual contact is escaped, it is not because of any human control of the situation.

Attempts have been made to construct sound-tubes pointing in different directions and supposed to give some clue, by the variation in intensity, to the direction from which the sound comes; such devices are, at best, but attempts to use an imperfect source of warning. A more promising idea is that recently proposed,—to use the indications of the very sensitive thermopile to give warning of an approaching source of heat. As the heat of a candle has been detected by this device at a distance of a quarter of a mile, it is not improbable that a steamer might be discovered much farther off.

So far as the best protection in case of collision is concerned, there seems to be little doubt that it should be in the ships themselves. It is practicable to construct a ship so that it may remain floatable after it has been freely opened to the sea. Bulkheads may have their great inconveniences, and are too often improperly placed, but the fact remains that great steamers have come safely to port with hulls damaged to an extent which would surely have sent them to the bottom, had it not been for the bulkheads. Danger at sea can never be wholly prevented, but many precautions may be taken, both in construction and in navigation, to render accidents not only very infrequent, but—what is far more important—free from fatalities.

The Depreciation of Machinery.

IN investigating the true financial condition of a manufacturing plant, the valuation to be placed upon the machinery is always a difficult question. Some maintain that its value should be based upon its earning capacity; others that it is worth no more than the cost of its present replacement; while in still other cases it is found that machines which a few years before were valuable assets have become of little or no value, because they have been superseded by other and far more efficient devices. These and other interesting points concerning depreciation for the subject of a recent editorial in *Engi-*

neering, from which we make some abstracts.

"For a long time it was customary—indeed, it is so still—to write off annually a given percentage of the value of machinery, as shown by the last year's balance-sheet. This causes a rapid depreciation at first, but the rate soon diminishes, until it scarcely varies at all, and this just at the time when the tool is really depreciating most rapidly. The result is that many large plants are becoming almost hopelessly antiquated, and, while the books show it to possess a good valuation, its earning power is *nil*.

"The ordinary methods of reckoning depreciation take no account of the important fact that machines grow yearly more specialised and more expensive. The lathe costing 200*l.* has to be replaced by one worth 400*l.*, or more, and no system of percentage on last year's book value will provide for this. It is only by writing off a fixed sum annually that the case can be met. The so-called absurdity of a machine being credited with a negative value is not an absurdity at all, when it is remembered that its successor will probably cost twice as much as it did. A manufacturing business cannot be run on the principle of gradually writing off all the capital, and then allowing it to drop. Much money has to be expended in directions from which it cannot be withdrawn. Reputation has to be created, and the confidence of customers to be obtained; and both these cost money. Any attempt to trade upon them by turning out inferior goods deteriorates them most rapidly, and, even when unimpaired, they are scarcely ever salable to another person for what they have cost.

"Business is like a race; the entrance money is only returned in the form of prizes. The man who drops out gets nothing back. Once a man has embarked his fortune in manufacturing, he can only regain it by being successful. He must constantly find more and more capital, and spend increasing sums on machinery; every year this necessity becomes more urgent."

A very important factor in the depreciation of machinery is the restless mental

activity of the age. Thousands of people are devoting their lives to the improvement of machinery, and the modern tool loses its value almost as rapidly when running as when idle.

"It is by no means likely that we have seen the worst—or the best—of this process. The pace has perceptibly quickened during even the past ten years, and it is certain to get still faster in the next decade. America leads the way in a fashion which is absolutely staggering. In her iron and steel works money is poured out like water on new machines. Old plant is thrown out as a matter of course, and the manufacturer who cannot find money to purchase new gets squeezed out of the trade, although his works may be perfectly equipped for every purpose, except that of making a profit."

It is impossible to say just how much every machine should be depreciated, for there is no general rule possible. Some standard machines maintain their usefulness for a long time, while other and newer machines may be rendered obsolete in a short time by the introduction of some improved tool capable of doing the same work at a fraction of the cost.

"The days of enormous profits are past, and for that reason every part of a plant must be worked at its highest efficiency. The machine that does not earn a profit is merely a useless encumbrance, however satisfactory it may be to look at, and it is actual economy to break it up with a sledge-hammer rather than to keep it filling up valuable space. This is a condition to which every machine comes in time,—often in a short time,—and, unless the owner has accumulated money to replace it by a better and a more expensive one, he has been living on his capital, whilst deluding himself with the idea that he was only spending his profits."

High-Pressure Steam at Collieries.

THE tendency to use high-pressure steam appeared first in marine practice, and there are few steamships of any pretensions to modern equipment which are not now operated at pressures of at least 160 pounds per square inch. In station-

ary practice, however, the introduction of high pressures has been more gradual, and, while some power plants are now running with high-pressure steam, in the modern sense of the term, very few collieries have as yet commenced the practice.

The desirability of using high-pressure steam in collieries is discussed in a paper by Mr. Hugh Bramwell, presented before the British Society of Mining Students, and published in the *Colliery Guardian*, and some of the points which he makes as peculiar to the conditions of colliery practice are worthy of consideration.

"At the outset it may be stated that colliery surface arrangements do not generally lend themselves readily to steam at such pressures—150 pounds and over. In cases of mills, engineering works, and electric light or power stations, the boilers can usually be placed immediately adjoining the engines they supply, and consequently all steam pipes can be kept within the buildings themselves. At most collieries, on the other hand, conditions exist necessitating the conveying of steam to various parts of the premises and entailing long lengths of more or less exposed steam pipes. Owing to the greater changes of temperature, the nature and care of such pipes are very different matters with high pressures from those experienced with pressures of about 50 pounds per square inch."

The economy in fuel, however, in most cases amply repays the cost and trouble involved, there being a decided gain both in the generation and in the application of the steam.

For the generating plant one still has the choice between shell boilers of the Galloway or Lancashire type, and water-tube boilers, such as the Babcock & Wilcox; the nature of the feed water will generally have much to do with the choice. The larger area of grate obtainable with water-tube boilers renders them well suited to colliery service, as inferior qualities of fuel may be more readily burned, and high pressures can be carried with safety.

Cast-iron pipes are inadvisable for high-

pressure service, and mild steel lap-welded tubes with welded-on flanges are recommended.

Plenty of bolts must be used in the flange joints, placed as close together as is practicable, since tightness cannot otherwise be obtained. The high temperature makes india-rubber gaskets useless, and some form of asbestos packing is recommended, preferably in connection with metal rings, either of copper or brass. An excellent packing is made of lead and asbestos cord, consisting of a small lead pipe covered with woven asbestos.

The necessity of making proper provision for expansion is much more imperative than it is with steam at lower temperatures, and care should be taken to avoid rigid hangers or supports. In draining the water of condensation the flow should be in the direction of the steam flow, if possible, and traps or separators should be provided at various points. Float traps are not so well adapted for this service as expansion traps, as the danger of collapsing or infiltration of water is greater, and the expansion traps answer well for the high range of temperature.

The covering of the pipes is a most important point, and the necessity of conveying steam long distances renders it imperative that condensation be reduced to a minimum. The economy apparently obtained by using a cheap non-conducting covering is soon over-balanced by the loss from condensation. There are greater differences in the non-conducting properties of the various pipe-coverings than one at first realises. By paying rather more in the first instance it is frequently possible to obtain an article having twice the efficiency of the cheaper forms, and this is of considerable importance with high temperatures. In addition to the immediate non-conducting covering, the steam pipes should, as far as possible, be under cover in separate culverts or passages.

In order to obtain the full economy practicable with high-pressure steam, it is imperative that the expansion be performed in two or three cylinders, and, in addition to the economy thus obtained, the excessive strains which would other-

wise occur are prevented. Colliery engineers must be prepared to compound all engines. Winding engines are the only class as to which there need be any difficulty or doubt. Owing to their intermittent working, they are, at best, extravagant steam-consumers, considering the work done and they must be under complete control. Compound winding engines are in successful operation in Germany, however, and it does not appear that the difficulties are greater than those involved in the construction and operation of compound locomotives.

There seems to be little doubt that there will be a continual tendency toward the use of higher-pressure steam in colliery practice. While the change may not come so suddenly as it did in marine service, it must be counted upon, and the above points include the principal features which must be considered in order to render the application successful.

The Present Status of Acetylene.

AMONG the important papers presented at the Belfast meeting of the Incorporated Gas Institute, that of Mr. Vivian B. Lewes upon "Acetylene and Its Modern Developments" is especially worthy of notice, as Mr. Lewes, who contributed largely to the prominence given to acetylene when it was first brought before the public, is therefore well acquainted with the history of the development of the subject.

Since the Edinburgh meeting in 1895, when the attention of the institute was first directed to acetylene as a commercial illuminant, many things have occurred to alter the position which it occupies. "Reputed dangers have vanished into the air, and unsuspected ones have taken their places; many schemes have been proposed, but the home office and the insurance companies have disposed of the majority of them; the question of cost has descended from the realms of transatlantic fiction to the concrete form of solid fact; and, now that the history of the gas has reached a stage which enables one to speak with something like confidence as to the part which acetylene is likely to play in the future, it needs no further

excuse for again choosing it as a subject of interest."

The first important point which has become perfectly established is that it takes about two electrical h. p. per hour to produce one pound of calcium carbide; hence the cost of acetylene is well defined. If electricity is to be used, the cost of carbide at the works can hardly be less than £16 per ton, which probably means, in most localities, £20 per ton delivered; and the efforts which have been made to produce the carbide by other means than the electric furnace show that at present such methods would probably be more costly than electricity.

Taking the average production of a ton of carbide as 11,200 cubic feet of acetylene gas, and allowing the value of the lime as a by-product to pay for the water and labour, we have the cost of the gas as practically 30s. to 40s. per 1,000 cubic feet, according to the price of the carriage of the carbide.

Under these conditions of cost, the uses of pure acetylene are so limited that it can at present only be considered in connection with some diluent which shall make it fall within the commercial limits of competition.

The most successful results in this respect are those which have followed the experiments of the firm of Julius Pintsch in Germany, by whom mixtures of oil gas and acetylene have been tested in many ways for the purpose of lighting railway-carriages. Many of the State railways in Germany are now lighted by this means, and, the safety of the mixture, even when subjected to a pressure of 10 atmospheres, having been demonstrated, its use is now permitted in Great Britain.

Photometric tests show that the addition of 20 per cent. of acetylene to oil gas doubles the illuminating power. Based on a price of £20 per ton for carbide, delivered, this makes a cost of about 14s. per 1,000 cubic feet for the mixed gas as against 8s. for the oil gas alone; as the illuminating power is doubled, the economy plainly appears. Another advantage which follows the increase in illuminating power is the greater length of time which

may be permitted to elapse between the charging of the cylinders, besides which less condensation and smoking appear than with oil gas when used alone.

Instead of using oil gas mixed with acetylene, Mr. Lewes suggests the use of methane as a diluent, and the low cost of methane leads him to believe that this may be a very desirable mixture. By using a slightly-modified form of water-gas generator, he is able to produce a diluting gas containing 30 per cent. of methane and 45 per cent. of hydrogen, having an initial illuminating effect of 10 to 12 candles, and costing 8d. to 10d. per 1,000 cubic feet. Mixing this with about 5 per cent. of acetylene, a gas is obtained having an illuminating value of 18 to 20 candles, which, being regarded as a mixture of perfect gases, gives no trouble as regards layering, and which, having the same specific gravity and illuminating power as coal gas, can be distributed and burned in precisely the same way. It is also found that mixtures of this gas with 50 per cent. of acetylene are not detonated, when compressed for railway-carriage-lighting purposes, at any temperature which it would be possible to attain in the cylinder; and it seems that this method of utilizing acetylene is pre-eminently the one which promises for it the largest and most remunerative future.

The Purification of Drinking-Water.

At the meeting of the British Association of Water-works Engineers at Southampton an interesting paper was read by Dr. Percy Frankland on the chemical and bacteriological examination of water, and, although no very novel views were offered, the whole formed an excellent and authoritative presentation of a very important subject.

It was first shown that, while chemical examination might reveal the presence of injurious constituents, negative results were by no means an assurance of the purity of the water, as a bacteriological examination might show it to be unfit for use.

Many waters are available in large quan-

tity which, although undoubtedly contaminated with sewage matters, are still contaminated to so slight an extent that chemical examination fails to detect any danger. Such waters, however, need not be wholly avoided, but can be rendered suitable for domestic use by some simple process of purification, such as storage in large reservoirs or filtration through fine sand.

In order to show the efficiency of sand filtration in removing bacteria, Dr. Frankland cites the average number of bacteria found in Thames water as supplied to London before and after filtration, and shows that in no case was the reduction less than 96 per cent., while in most months it exceeded 99 per cent. In the month of January the average number of bacteria in one cubic centimetre was 92,000 before filtration, while, after filtering, this was reduced to 129. Similar results were shown for other months.

The proper way to ascertain whether filtration is being properly carried on is to maintain a continual bacteriological control. A new sand filter is comparatively inefficient; the filtrate should be permitted to run to waste, until an examination shows that the sand has acquired the power of retaining the micro-organisms in the water, and a similar practice should prevail every time the filter-beds are cleaned.

"Just as the bacteriological examination has enabled the real value of artificial purification processes to be ascertained, so also by its means can it be discovered whether or not natural purification processes are operating with efficiency. Thus the safety of deep-well water depends upon the exhaustive filtration to which it has been subjected in the porous strata of the earth; and, if the water gaining access to such a well has really been thus filtered, it should be almost entirely free from bacteria, and this, in regard to properly-constructed wells, is found actually to

An important feature in connection with sand filtration, and one which is often imperfectly appreciated, is the necessity of a constant rate of filtration. Sudden changes in the rate, or shock in flow, are

most injurious, and must be carefully avoided, and all attempts at forcing the rate must be prohibited. The filters must be independent of the varying consumption, sufficient storage of purified water being provided; thus the steady, uniform operation of the filter beds need not be interrupted or modified in any way between the periodical cleanings.

There seems to be no doubt that sand filtration affords an effective means of rendering water-supplies available for municipal use when they would otherwise have to be rejected, and the precautions urged by Dr. Frankland serve only to show the effective nature of the process when properly installed and maintained.

The Outcome of Sanitation.

A VERY instructive review of the outcome of the work in sanitation done in England during the past sixty years is found in a lecture by Dr. Louis C. Parkes, published in the *Journal of the Sanitary Institute*.

Starting at the beginning of the present reign, Dr. Parkes shows how the very complete and accurate registration commenced at that time has resulted in the production of a mass of data from which we have been able to learn much concerning the sources of disease and the sanitary methods of prevention.

Not only are we now in possession of the facts as to the mortality from different diseases, but, owing to the immense studies made in the medical and allied sciences, we now recognise many of the direst diseases and worst scourges of the human race as preventable by properly-administered methods of sanitation, and we have already gone a considerable way on the road to completing such methods.

At the risk of going somewhat into medical statistics, we may note some of the successes made in fighting disease during the period under consideration. The death-rate from smallpox has diminished 96 per cent., and that from fevers 82 per cent.; tubercular diseases have had their death-rate diminished 46 per cent.; diarrhoea, 30 per cent. The only disease which has not shown a reduction in its

death-rate is diphtheria, which is about the same as it was thirty years ago (1861-1865), and is about double the rate prevailing in the fifteen years 1866-1880. The death-rate for England and Wales has diminished from 22.4 per 1000 in 1841 to 18.7 per 1000 in 1895.

The share which sanitary engineering has had in producing these favourable results is undoubtedly large.

First among them may be named pure water-supplies. A very large number of polluted sources formerly freely used have been replaced by improved works, and all the principal towns of the country are now supplied with water of exceptional purity, as are also many rural districts; the millions sterling spent in these magnificent enterprises are among the most beneficial outlays of the country's wealth.

The sanitary methods of sewage disposal now in use, compared with those existing sixty years ago, have had much to do with the advances made in public health. Not only is the sewage conveyed away from the town in a comparatively fresh and innocuous condition, but its further disposal has been given much study. The right methods of disposal and utilisation of sewage have been the subject of much controversy and experiment, and it is only recently that we have come to recognise the part played by natural forces in the purification effected by the various processes now in vogue. Not many years ago the idea generally prevailed that a large volume of sewage required a large area of land for its disposal, so as to produce an effluent of sufficient purity to be permitted to pass into streams. Sewage farms, however, were found to be costly to acquire and expensive to maintain, and the return from sewage-grown produce was an insufficient set-off against these expenses. At the present time sewage can be clarified by precipitation, and subsequently purified by filtration through artificially-constructed filter beds (which are really cultivating grounds for the nitrifying organisms that effect the chief part of the purification) on an area of land which would be absolutely useless for crude irrigation.

The Wear of Chains.

WHEN we consider the important duties chains are frequently called upon to perform, and the serious consequences of failure, any contribution to technical literature which helps to increase the security of such members is worthy of notice and commendation. An excellent paper upon the wear of chains, by Mr. R. Weatherburn, in a recent issue of the *Engineer*, gives some interesting points about a feature of chains which has been too generally neglected.

The strength of new chains is a subject which has been discussed at various times, and tests of chains of various forms have been made by competent authorities, and are matters of scientific record. The fact that chains are subjected to wear, however, seems to have been generally neglected by the text-books and testing-laboratories; hence the desirability of calling attention to the causes and nature of the deterioration.

Mr. Weatherburn divides the wear into two kinds, the determinate, or visible, being local in action and due to abrasion, distortion, and movement, and the indeterminate, or invisible, being the slow, but sure, change from the fibrous to the crystalline condition in the organic structure of the metal.

Both wears are contemporaneous, but the two are not equal. The determinate wear can be dealt with only by removal and substitution, while the indeterminate can be remedied by periodical annealing.

The determinate wear can be modified very greatly by care in design, and is always greatest in ill-designed chain, as indeed in other ill-designed machines.

Acute knuckling motion of links passing around sheaves or drums of small diameter can usually be avoided, and does not occur in cranes of the best design, and the race or channel for the links in winding drums should be near enough to the size of the chain to prevent a canting or rolling motion. A twist in a chain is a frequent cause of determinate wear, and especial care should be taken, both in the manufacture and in the subsequent use, that no twist occurs. The righting of the

twisted portion under load produces excessive local wear, and may reduce the life of the chain by one-half.

Defects due to imperfections in manufacture sometimes appear, and are generally made evident by unequal wear. The rapid wear of one link of a chain, or the greater wear at one end of a link than at the other, can have but one solution; there must have been some irregularity in the working so that the metal, by more or less hammering at doubtful temperatures, has become injured.

"Indeterminate wear is not general throughout the length of chain, but is even more localised than outside wear, being subject not only to the same influences which produce outer wear,—*viz.*, weight and motion,—but also to differences of temperature, shocks, etc., which mostly affect those portions of the chain which receive the most movement. The influence of cold on the cohesion of chains is very remarkable, and should be taken seriously into account in cold weather or in cold climates. Fortunately, in spite of the insidious and dangerous character of the unseen wear, it can be dealt with much easier and more generally than determinate wear. The process of annealing, or, in other words, restoration, is so easy as to come within the range of every user of chain, although the easiness of the process may cause it to be carelessly done. Annealing can be accomplished in a furnace, but the temperature should never be more than that represented by what is known as red; any higher visual temperature may produce scaling, which would be loss."

In order to provide sufficient elasticity, it is better for the links to be made somewhat oval in form, as this enables shocks to be taken up without causing undue stress.

It is evident, therefore, that too much dependence should not be placed upon a chain merely because it has satisfactorily passed a critical inspection, when new. Frequent periodical inspections should be made, worn parts should be renewed, and occasional annealing should be performed, if the original quality is to be maintained.

THE CONTINENTAL PRESS

Inclined-Plane Canal Lifts.

IN the discussions of the plans submitted for the construction of water communication between the Danube and the North sea, the problem of overcoming the intervening elevation has been a prominent feature. The use of the ordinary system of locks involves much delay, and adds to the operating expense, while the construction of hydraulic lifts, such as are in use at Les Fontinettes in France and at La Louvière in Belgium, increases the first cost.

An alternative scheme is that of using an inclined-plane lift; an elaborate account of such a construction is given by Victor Schönbach, in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, together with the discussion which the paper received at its presentation before the society.

The canal inclined-plane is virtually a form of ship-railway, the essential feature being that it is designed to overcome a steep grade. Numerous modifications in ordinary railway construction are necessary to meet the peculiar conditions, and these special features are fully considered in the paper.

Instead of conveying the boat in a direction parallel to its axis, the direction of the lift described by Herr Schönbach is at right angles to the line of the canal, the two canal sections being parallel to each other, one, however, being placed at a higher level than the other, as the general plan of the waterway was so designed as to concentrate the entire difference in level between the terminals at a few convenient points where such construction is practicable.

The boat is carried in a tank car, the general arrangement being somewhat similar to that seen in the well-known transfer table used in railway yards and shops for the shifting of locomotive engines from one track to another. The greatly-increased weight, as well as the necessity of

providing for the maintenance of parallelism of the wide structure upon the tracks, adds materially to the difficulties of the problem.

As planned by Herr Schönbach, a tank of $230 \times 28 \times 7$ feet would be required, the total weight of which is estimated at more than 2,000 tons, the water alone weighing about 1,250 tons. It would be almost impossible to insure the equal distribution of this weight over a number of journal bearings; the design, therefore, includes the use of a special system of roller bearings, the rollers being connected in sets by endless chains, and passing under the framework by which the car is supported. Since the pressure comes directly upon the rollers, the only function of the roller journals is to keep them in place and insure their parallelism.

It is evidently possible to construct such an inclined plane with two tanks, each counterbalancing the weight of the other, but the design shown is arranged with counterbalance weights, traveling upon rails between the tracks for the roller bearings and connected to the tank cradle by wire cables.

The propulsion of the cradle is effected by electric motors acting, by means of a train of gearing, upon a rack rail, and the general details of this portion of the design are worked out in accordance with experience with heavy traction in other lines of work.

The arrangements of the tank are not greatly different from those in use with the French and Belgium hydraulic lifts, the joints at the ends being made watertight by the use of an inflatable hose packing, distended after the gates are closed and secured. The details of manipulation are practically identical with the hydraulic-lift practice.

An interesting portion of the paper is devoted to the comparative cost of the inclined plane and the old-style lock system, and the relative figures are embodied in

diagrams which show clearly just where the cost of the inclined-plane system passes that of the former practice. Taking a plane with a rise of one in five, for lifts from 10 to 100 metres, the cost, both of installation and of operation, is greatly in favor of locks for lifts up to about 30 metres, after which the two methods approach each other; while for the higher lifts,—from 80 to 100 metres,—the advantage is on the side of the inclined plane.

For ordinary work, therefore, the inclined-plane canal lift is not adapted, but in such cases as are contemplated in Germany it appears probable that the system will prove an important factor in solving the problem, now so earnestly discussed, of cheaper internal transport between the ports of the Danube and those of the North sea, both for grain and mineral traffic.

Compression in Steam Cylinders.

THE important experiments of Professor Dwelshauvers-Dery upon the nature, causes, and extent of the losses due to compression of exhaust steam in the cylinders of steam engines were noticed and discussed in these columns, at the time of their original publication. There now appears in the *Revue de Mécanique*, in which the original paper of Professor Dery was published, a critical examination of the subject by Professor Boulvin, and the two papers form a thorough and valuable investigation of this mooted question.

According to the experiments of Professor Dery, made upon the experimental engine at the University of Liège, the consumption of steam per i. h. p. increased with an increase of compression, following a law which gives a very rapid augmentation. Thus at 45 revolutions, in passing from 0 to 4.10 compression, the increase in steam consumption is 57 per cent., and at 60 revolutions, in passing from 1.10 to 4.10 compression, it is 64 per cent.

The experiments of Professor Dery were carefully reviewed by Professor Hubert in a paper published in the *Revue Universelle des Mines*, and the conclusions reached by him were formally enunciated as fol-

lows: "Contrary to the general supposition, compression by the piston, in non-condensing engines, is injurious and wasteful, instead of being economical, and, the greater the degree of compression, the greater the loss."

In spite of the care with which these experiments were made, Professor Boulvin is not altogether disposed to accept these conclusions, and, in discussing the tests, he adds the results of experiments of his own, in order to throw some light upon the subject.

It is a well-known fact that nearly all engines of high grade in practical service are operated with a high degree of compression, and, although this is undoubtedly partly for the purpose of cushioning the inertia of the moving parts and avoiding thump, it is also found that more economical results are obtained in practice with than without compression. It is possible for engines to be so constructed that compression will not be required for the purpose of insuring quiet running, and, if any such gain as is indicated by Professor Dery's experiments were obtainable, it seems as if practical engine-builders would not be slow in endeavoring to secure so great a measure of economy.

In order to reconcile the apparent contradiction, Professor Boulvin re-examines the experiments made at Liège, applying the entropy diagram as deduced from the indicator diagrams published by Professor Dery, and the manner in which the analysis is worked out is a most instructive example of the practical application of the entropy diagram.

The paper of Professor Dery is extended by the addition of an illustration and description of the engine upon which the tests were made, and this assists very materially in explaining the points made by both investigators.

It is plainly shown that, when the clearance space is filled entirely with live steam, and there is no compression whatever, and when the cylinder walls are assumed to be absolutely inert as regards heat, the loss due to clearance will be in proportion to the volume of the space and the press-

ure of the steam, all other things remaining constant. If, however, with inert walls, there is a complete compression,—*i. e.*, a compression up to initial pressure,—the result, so far as steam-consumption is concerned, is the same as if there was no clearance whatever.

If we assume the walls to possess any given degree of conductivity, we have, for the two cases of no compression and complete compression, in the first, the losses due to conductivity and to clearance, and, in the second, the gains due to compression opposed to the losses due to the walls.

It is this last condition which usually obtains in practice, and it is this case which Professor Boulvin examines most fully.

In so doing he maintains that Professor Dery has confused two things which should properly be kept distinct, and holds that the real cause of loss is found solely in the action of the cylinder walls. This loss exists, regardless of the existence or absence of compression, and the only way in which it can be reduced is by supplying heat from some other source. The other source may be that of compression of exhaust steam by the piston, the latter being actuated by pressure previously furnished by live steam; or it may be live steam itself, furnished directly from the boiler to a steam jacket surrounding the cylinder walls.

The true conclusion of the Liège experiments, therefore, as enunciated by Professor Boulvin, is not that compression is very wasteful, but that it is more wasteful than jacketing. To use the words of his own conclusion, "it is more economical to reheat the walls by live steam than by the work of compression, because this work, being derived through a cycle of low efficiency, involves a large expenditure of heat."

Professor Boulvin expresses his sincere admiration of the laborious and valuable experiments of his colleague, and an appreciation of their value and importance, and avows his only intention to be that of further elucidation of the deductions from them.

The Electrical Transmission of Energy.

IN connection with the formulating of a law regulating the transmission of energy, the department of public works of France has furnished to the chamber of deputies a report upon the electrical transmission of energy, and the document, prepared by M. A. Blondel, is now published in the *Annales des Ponts et Chaussées*, forming an elaborate review of the whole subject.

Beginning with an estimate of the magnitude of the natural sources of power at our disposal other than the combustion of such fuel as may be available in the form of coal, wood, and petroleum, M. Blondel refers, in general, to the future possibilities of power-generation in the cases of the tides, the winds, and the waves, and gives some interesting data about water power. Thus, for instance, the Seine alone, at the various dams along its course, represents 25,000 h. p., and the total water power available in France has been estimated at 10,000,000 h. p. The total power of the Rhine at the falls of Schaffhausen represents 1,750,000 h. p., although but a small portion of this is at present utilized, and the total water power already harnessed and utilized in Switzerland exceeds 200,000 h. p. M. Blondel does not assume that water power is destined to supersede coal,—at least not for a long time,—and adds that electrical transmission appears likely to enable coal mines now unavailable to be worked by conversion of the fuel into power on the spot, in which case the cost of fuel transportation would be avoided by direct transmission of power.

A general discussion of the generation is given in the paper, showing the capabilities and limitations of the direct current, and also the especial features of polyphase alternating currents, together with the methods of transmitting and transforming them. The most extensive portion of the paper, however, is that which deals with the applications of electrical energy, and much valuable information is given concerning existing installations for industrial purposes.

Apart from lighting and tramway service, the growth in the electro-chemical

and electro metallurgical industries is a most significant feature in connection with the commercial exploitation of the electric current. It is stated that upwards of one hundred and twenty-five tons of silver are electrically deposited every year, while the magnitude of the electrotyping industry has not been computed. The direct refinement of copper, the winning of aluminum, and the production of the carbides of calcium and silicon are industries which have been practically created by the development of electrical energy.

When we consider the transmission of motive power by various methods, it is evident that electricity is less wasteful than any other known agency. The efficiency of compressed air ranges from 35 to 55 per cent., the latter figure being reached only in the case of reheating, while for moderate distances electric transmission easily attains an efficiency of 80 per cent. The experience in Switzerland with teledynamic cables demonstrated a loss of 4 per cent. for every 100 metres, while with high-pressure water 60 per cent. is the maximum efficiency so far reached.

The general tendency to use electric transmission in machine shops is noted, and the advantages over belting and gearing are shown to be such as to make its growth certain and rapid. The use of electric elevators in business buildings and hotels, and of electric cranes and hoists in warehouses and commercial establishments, must also furnish a continually-widening field of applications.

In mining operations the convenience and safety of electricity both for power and lighting are considered, and numerous installations, in France, Belgium, and Germany, are noted.

In discussing the question of the long-distance transmission of power by electricity the commercial features receive the consideration which their importance demands. The cost of the line constitutes one of the most important questions, but sufficient data are given from existing installations to show that an economical transmission is possible within limits of 50 kilometres (about 30 miles) and, with

high-tension alternating currents, probably much farther.

At the same time the fact is emphasised that the immediate future of electricity in the industrial arts depends largely upon the grouping of the industries about the source of power. Great cities have been built up heretofore because of proximity to harbors, fuel or mineral deposits, and lines of transportation, and proximity to natural sources of power will prove an equally potent factor in urban and industrial growth.

The electric current is simply a means enabling the power to be set to work, and, the less of it is wasted in transmission to a distance, the better. Transportation of the manufactured product is an easy matter, but power is best utilized near its source.

Motors for Blast-Furnace Gases.

MUCH has been said and written during the past few months about the use of blast-furnace gases in internal-combustion motors, and several working trials have been made, of which notice has been taken in these columns.

One feature of these experiments which has an important bearing upon the success of the idea is treated in a paper in *La Revue Technique*,—*viz.*, the modifications to be made in the motor in order to adapt it to the gases to be employed.

When it was first proposed, early in 1895, to use the furnace gas in a motor at Cockerill works at Seraing, in Belgium, the engineers of the establishment, MM. Bailey and Kraft, took a Simplex gas engine as arranged for use with producer gas, after assuring themselves that the gases discharged from the furnace were similar to the product of a gas producer. This engine, of 4 h. p., was started in December, 1895, and ran successfully for eighteen months, averaging sixteen hours per day.

Some experiments with this little engine showed that a modification in construction practically doubled its power, and, with the experience thus gained, plans were made for a new engine, to develop not less than 150 h. p. with furnace gas,

operating a François air-compressor. The designs for this machine were made by M. Delamare-Deboutteville, and executed at the works at Seraing, and it was started in a very satisfactory manner in April of this year, delivering 200 h. p. without difficulty, using the gas ordinarily furnished by the furnaces at Seraing.

The principal difficulties to be encountered in using furnace gas in a motor are the presence of dust and the tardiness of ignition. In this case the dust is successfully removed by passing the gas through three pairs of Korting scrubbers, these consisting of towers five feet in diameter and twenty feet high, filled with coke moistened with a water-spray. Ordinarily the gas proceeds directly from the scrubbers to the motor, being impelled by an exhauster operated by an electric motor, but it can be diverted to a gas-holder either for storage or measurement.

The engine itself is a heavily-built machine with single cylinder, operating on the usual Beau-de-Rochas cycle, the principal feature being that the compression is carried up to eight atmospheres, the ignition being by electric spark, and the governing being effected by varying the admission of air. The cylinder is 300 millimetres bore (11.8 inches) and 1 metre stroke (37.97 inches), and the engine makes 100 revolutions per minute. The fly-wheel is 4 metres (13 feet) in diameter and weighs 15 tons.

In considering the difficulties of operating engines with such gas as can be obtained from the ordinary blast furnace, the principal objection which has been raised is the presence of dust; and Herr Lürmann, in his discussion of the subject at the meeting of the Eisenhüttenleute (see *ENGINEERING MAGAZINE*, June, 1898, page 480), maintained that no process of scrubbing could so eliminate the dust as to permit the gas to be used without injury to the cylinder. As a matter of fact, the little 8-h. p. engine at Seraing ran satisfactorily for four months without the cylinder being opened, and, when examined, showed no signs of injury. There are few steam boilers which could be operated four months without cleaning.

Another objection which has been raised to furnace gas is the irregularity of composition, but at Seraing this difficulty was not encountered. On the contrary, frequent analyses of the gases showed the composition to be nearly uniform, and the calorific power, as determined by the Mahler bomb, varied only between 800 and 1,000 calories per cubic metre (90 to 112 B. T. U. per cubic foot).

The mechanical success of this 200-h. p. gas engine has been such that the results of economy-tests will be awaited with interest. The high compression appears to have removed any difficulty with regard to ignition, and the management at Seraing seems to have sufficient confidence in the system to announce the determination of proceeding to the construction of a motor, on similar lines, of 400 to 500 h. p., for operating a blowing engine for regular furnace blast.

Automobile Cabs.

ONE of the first practical uses to which the modern automotor was put was that of cab service in the city of Paris, not only because of the demand for such service, but also because the excellence of the pavements made the work easier for the vehicles than road-traveling.

In order to test the availability of the various automobiles in general use for city cab service, the Automobile Club organized a series of trials, which took place from June 1 to June 12 of this year, and which are described and discussed at length in several publications, among which we may mention *L'Electricien*, *Le Génie Civil*, and *La Revue Technique*.

Three routes were laid out through various portions of Paris, these being selected so as to afford the best possible tests as regards grades, narrow streets, and difficult conditions of travel.

Each of these routes represented 60 kilometres of travel (about 37 miles), and each vehicle was required to traverse each route three times. The power consumed was also tested by trial runs of 1,000 metres, both on a level and on the ascent from Suresnes to Mont Valerien,—the latter being a grade of more than 8 per cent.

Tests were also made of the ease of manœuvring and of the promptness with which the brake can be effectively applied under speed.

Twelve vehicles took part in the tests, of which eleven were propelled by electricity and one by petroleum. Illustrations and descriptions of the various cabs are given in *La Revue Technique*, enabling their general construction to be readily understood, although no working details are given.

The most notable departure exhibited by any of the vehicles from the ordinary type of automobile was that of the Jean-taud cab, in which the accumulators and motor were placed in a separate portion in front of the cab proper, the latter being therefore hauled by the motor section which practically takes the place of the horse. The operator is mounted above and behind on the cab, in the same manner as the driver of a hansom, and the motor section is so low and unobtrusive that the occupants have a clear view of the road before them.

This arrangement operated so satisfactorily as to gain the first prize of 1,000 francs, and it seems probable that a similar design for vehicles of other types would offer numerous commercial advantages.

Nearly all the other automobiles exhibited and tested resembled existing cabs, the absent horse being replaced by storage-batteries beneath or behind. The conservative manner in which the ideas of the carriage-builder were retained in minor details showed the reluctance of the constructors to avail themselves of the opportunities for originality at their disposal.

The Peugeot automobile, operated by a gasoline motor, excited the admiration of the jury and the spectators by the ease of its operation and the general handiness which it displayed, but the cost of the fuel, gasoline, which it employed placed it out of competition with the electrically-propelled vehicles, and prevented it from obtaining an award.

The trials were well sustained by nearly all of the vehicles entered, and the result showed that, for a city like Paris, where good pavements are the rule, but hilly

sections, narrow streets, and some rough sections are also included, the automobile is well adapted for general cab service. One feature of the trials, however, must be noted,—namely, that the vehicles were in all cases operated by skilled drivers, these in many instances being the inventors or constructors themselves; equal ability could hardly be expected for this work in a general cab service. There is no reason to believe, however, that a greater capacity is required for a motor cab driver than for a motorman on an electric trolley, and this feature will hardly become an obstacle to the general introduction of automobiles.

Anti-Friction Alloys.

AMONG the various investigations conducted by the French Société d'Encouragement there is a series conducted by a special committee for the study of the properties of the various metallic alloys, and in a recent issue of the *Bulletin* of the society there is a report by M. G. Charpy upon the various white alloys commonly called anti-friction metals.

This subject possesses both a practical and a scientific interest, since such alloys are widely used in the arts, and the application of the recent methods of investigation into their physical constitution has revealed important facts concerning their properties.

In France the practical value of white-metal journal boxes for railway carriages was demonstrated by the experience of the Paris-Lyons-Mediterranean Railway, on which, after a number of years' trial, the report of the engineer, M. Chabal, stated not only that there were fewer cases of heating than with bronze boxes, but also that on heavy, slow trains there was a reduction of 20 per cent. in the frictional resistance.

The term "white metal" is rather indefinite, but is generally intended to include alloys soft enough to adapt themselves, to a greater or less degree, to the configuration of the journal; but M. Charpy gives tables of alloys of tin, copper, and antimony; of copper, tin, and zinc; and of miscellaneous composition; citing the authority, composition, and

service in a manner which enables the nature of the material under discussion to be identified very closely.

It might be supposed that a metal which could adapt itself under pressure to the form of the journal would be too soft to afford a suitable wearing resistance, and the conditions of plasticity and durability appear to be too contradictory to be embodied in the same material. The only way in which both properties can be obtained is to use an alloy consisting of hard particles embedded in a plastic alloy. This constitution is practically that which has been attained by empirical methods, as subsequent researches have verified.

Accepting these two properties as essential for a satisfactory bearing metal, it is evident that there must be two corresponding methods of test. The plasticity may be determined by suitable compression tests, and the compressibility should not be greater than is necessary for adaptation to the form of the journal; else there will be a continual yielding, which is most injurious. The compression tests also show the resistance to crushing,—a very essential quality.

The physical constitution is determined by a microscopical examination. The proper composition for an anti-friction metal is very clearly defined under the microscope, and by polishing the surface upon an elastic support the softer portion is worn away, leaving the hard particles in sufficient relief to give a well-defined texture even without the aid of etching. The resistance to wear during polishing also gives an indication of the hardness.

Adopting these methods, M. Charpy proceeds to examine a number of the more-generally-used alloys, beginning with the binary alloys, such as lead and antimony, and following with ternary alloys, as those of lead, tin, and bismuth, using in the latter cases the well-known triangular model of Thurston as a means of indicating the results to the eye.

One of the most interesting features of the subject is the relation between the relative fusibility of the constituents of an alloy and the corresponding physical properties, as revealed by the metallographical

examination. By reproductions of numerous microphotographs the successive phases of solidification are shown, and the influence of the rates of cooling is clearly indicated by the variations in crystalline and molecular constitution.

The detailed results of this important investigation are too voluminous to be given here, and the reader must be referred to the original paper; but the general conclusions are of interest.

The desired constitution of a plastic material enclosing hard grains, M. Charpy asserts, can be obtained with binary alloys, the hard particles being composed of a simple metal, such as antimony, or of a composition of antimony and tin, antimony and copper, or tin and copper. It is generally preferable, however, to use ternary alloys, since the complex composition of the cementing portion renders it possible to obtain the desired qualities more readily and certainly. Especially valuable in this respect are the alloys of bismuth, lead, and tin, and the methods of investigation given in the paper of M. Charpy enable the characteristics of any such alloy to be obtained with a minimum number of trials, within the limits available for practical purposes.

The general physical constitution may be determined by micrographical examination, and a few compression tests will show whether the alloy is too hard or too soft. For the best results it should yield steadily and uniformly to increasing pressure, neither breaking into fragments or giving way too readily.

These tests having been made in the laboratory, the choice of the most available alloy for practical use will be controlled by commercial conditions, and there will be no need for empirical methods in any respect.

In addition to the investigations of the soft bearing metals, the paper gives the results of examinations of ternary alloys of copper, tin, and antimony; lead, tin, and antimony; copper, lead, and antimony; zinc, tin, and antimony; and copper, tin, and lead. These will be of much use for special purposes, and furnish valuable information not generally available.

Transportation at the Paris Exposition.

At a recent meeting of the commission of the Paris exposition of 1900 having in charge the subject of electrical transportation of visitors within the exhibition grounds, a number of projects were examined and discussed, as reported in *La Revue Technique*. The great extent of the grounds, and the fact that there are several sites situated at considerable distances apart, render it especially desirable that the transportation facilities should be complete and of ample capacity, and hence the requirements were very carefully drawn by the commission. Five schemes were submitted, the French Thomson-Houston Company, the Decauville Company, the Electrical Company of the Left Bank at Paris, M. L. Francq, and M. de Mocomble being the competitors.

Each of the first three proposed the construction of a single-track electric railway of one metre gauge; the fourth proposed to construct a double-track railway; the fifth offered a single-track railway and a double-speed traveling platform.

Each bidder had a special financial scheme to submit. The Thomson-Houston Company was the only one demanding a subsidy, asking an advance of 1,500,000 francs, in return for which the exposition administration was to get the gross receipts from all passengers in excess of 9,000,000 and up to 15,000,000, and two-thirds of the receipts from all passengers in excess of 15,000,000.

The Decauville Company offered 50 per cent. of the net receipts, after all expenses had been deducted, and 5 per cent. additional of the same receipts for participating in the personnel of the exposition.

The Company of the Left Bank offered to allow the administration 20 per cent. of the gross receipts, and 25 per cent. of its net profits.

M. Francq proposed that the administration should pay all costs of installation above 3,500,000 francs, and offered to pay 1 centime per passenger if the number should exceed 15,000,000, 2 centimes if it should exceed 20,000,000, etc.

M. de Mocomble made the simplest proposition of all, standing ready to bear

the costs of installation, and to pay 1 centime for every passenger carried, regardless of the number.

The proposed fares were as follows: Thomson-Houston and Decauville each proposed but one class, with a fare of 25 centimes; the Company of the Left Bank and M. Francq proposed two classes,—one at 50 centimes, and a second at 25 and 30 centimes; while M. de Mocomble planned to charge 25 centimes on the railway and 50 centimes on the traveling platform.

Single-track roads seemed hardly adequate to the immense traffic to be expected, and it was not so much the desire of the commission to make a profit upon the transportation as to be relieved from the management of the matter, and at the same time secure ample means of handling the greatest crowds. The double-track scheme of M. Francq contained a possibility of involving the administration in the completion of the construction, and the rates of fare proposed by him were higher than the maximum official scale.

The scheme of M. de Mocomble alone remained, and it received, therefore, careful consideration. If its operative success could be assured, there is no doubt that the traveling platform would offer a transporting capacity far greater than any railway system involving trains of cars; instead of 25,000 passengers per hour, it could readily handle 35,000 to 40,000.

The full details of the proposed structure have already been given in these columns (see *ENGINEERING MAGAZINE*, November, 1897, p. 317), and the manner in which the details have been worked out should convince any one of its practicability. The commission, however, has required that M. de Mocomble shall construct a small circular section of traveling platform according to his plans, and demonstrate within six months the entire feasibility of the system. In order to reimburse him for the expense of this preliminary construction, the administration is to waive its claim to any receipts until the number of passengers carried shall have reached 10,000,000,—this amounting to a sum of 100,000 francs, the estimated cost of the experiment.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, in the original language, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of \$1.35. In ordering, care should be taken to give the number of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices;—15c. each, or fifteen for \$2, forty for \$5, and one hundred for \$12.

Each coupon will be received by us in payment for any 15-cent article catalogued in "The Engineering Index" of THE ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be received for each 15 cents: thus, a 30-cent article will require two coupons; a 45-cent article, three coupons; and so on. With a supply of these coupons on hand no letter writing is required. Simply fill in the number of the article and your address, and mail the coupon to us.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.

Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.

Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

- Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Engineer. *w.* London.
 Engineer. *s-m.* New York.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, Tenn.
 Engineering and Mining Journal. *w.* New York
 Engineering Journal. *s. an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
 Fire and Water. *w.* New York.
 Forester. *m.* Washington, D. C.
 Forum. *m.* New York.
 Foundry. *m.* Detroit, Mich.
 Gas Engineers' Mag. *m.* Birmingham, England.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Gunton's Magazine. *m.* New York.
 Harper's Weekly. *w.* New York.
 Heating and Ventilation. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago, Ill.
 Iron Age. *w.* New York.
 Iron and Coal Trades' Review. *w.* London.
 Iron & Steel Trades' Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco, Cal.
 Journal Franklin Institute. *m.* Phila., Pa.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *q.* New London, Conn.
 Journal Political Economy. *q.* Chicago, Ill.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kan.
 Locomotive. *m.* Hartford, Conn.
 Locomotive Engineering. *m.* New York
 Locomotive Firemen's Mag. *m.* Peoria, Ill.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore, Md.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Master Steam Fitter. *m.* Chicago, Ill.
 Mechanical World. *w.* London
 McClure's Magazine. *m.* New York.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, Pa.
 Mining and Sel. Press. *w.* San Francisco, Cal.
 Mining Journal. *w.* London.
 Mining Reporter. *w.* Denver, Col.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Monatsschrift des Württ. Vereines für Baukunde.
 10 parts yearly. Stuttgart.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, Ind.
 National Builder. *m.* Chicago, Ill.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Physical Review. *b-m.* New York.
 Plumber and Decorator. *m.* London
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineer's Club. *q.* Phila., Pa.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago, Ill.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago, Ill.
 Railway & Engineering Review. *w.* Chicago, Ill.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revue de Mécanique. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Sanitarian. *m.* Brooklyn, N. Y.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerisches Bauzeitung. *w.* Zurich.
 Science. *w.* Lancaster, Pa.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Scientific Machinist. *s-m.* Cleveland, Ohio.
 Scribner's Magazine. *m.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, N. Y.
 Southern Architect. *m.* Atlanta, Ga.
 Stahl und Eisen. *s-m.* Dusseldorf.
 State's Duty. *m.* St. Louis, Mo.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, N. J.
 Stone. *m.* Chicago, Ill.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston, Mass.
 Technograph. *yr.* Champaign, Ill.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. Civil Engineers. *m.* New York
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago, Ill.
 Western Railway Club, Pro. Chicago, Ill.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, Conn.
 Year Book of Soc. of Eng. Univ. of Minn.
 Zeitschrift für Lokomotivführer. *m.* Hannover.
 Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Cathedral.

Peterborough Cathedral. Description of the interesting fan vaulting of this cathedral, by the late Prof. Willis. Extract from his essay on the "Construction of the Vaults of the Middle Ages." Ill. 4000 w. Arch, Lond—July 8, 1898. No. 21528 A.

Dome.

The Steel Dome for the Yerkes Observatory, Lake Geneva, Wis. Illustrated description of the features of particular interest to engineers, the chief being the main dome and its operating machinery. 2800 w. Eng News—July 14, 1898. No. 21486.

Dome Construction.

Notes on the Theory of Dome and Tower Construction. (Beitrag zur Theorie der Kuppel- und Turm-Dacher.) R Kohfahl. Discussing especially the details of framed structural metal domes, spires and towers, both from a theoretical and practical standpoint. Two articles. 9000 w. Zeitschr d Ver Deutscher Ing—June 25, July 2, 1898. No. 21736 each D.

Fire Regulations.

See Municipal Engineering, Miscellany.

Foundations.

Reconstruction of a Chicago Building Sub-structure. Illustrated description of method of underpinning a heavy 80x100-ft. building to put in a sub-basement, The Equitable Building. 1000 w. Eng Rec—July 9, 1898. No. 21421.

The Ivins Building, New York. Illustrated description of foundations and metal work in a 424-ft. building, the highest yet constructed. 3000 w. Eng Rec—July 16, 1898. No. 21507.

Tall Building.

Park Row Building, New York. Brief description with illustrations. 1400 w. Engng—July 8, 1898. No. 21541 A.

Theatre.

The Olympian Theatre of Palladio at Vicenza. Extract from a work by Albert A. Hopkins. Illustrates and describes the oldest permanent theatre in Europe, built since the time of the Romans. 1300 w. Sci Am—July 16, 1898. No. 21475.

HEATING AND VENTILATION.

Factories.

Ventilation of Textile Factories. W. H. Casmev. Read before the Yorkshire Dyers' and Colourists' Assn. Part first is largely arguments showing the necessity of fresh air both from a commercial and sanitary point of view. 2500 w. Prac Engr—July 3, 1898. Serial. 1st part. No. 21540 A.

Hot-Air.

An Interesting Furnace Heating System. Describes a system which successfully overcomes serious difficulties, designed by William G. Bar-

rows, of Utica, N. Y. Ill. 1000 w. Met Work—July 16, 1898. No. 21494.

Mills House, No. 1.

Heating, Ventilating, and Sanitary Equipment of a Modern Hotel. C. Wadsworth, Jr. Read at Atlantic City meeting of the Am. Soc. of Heat. & Ven. Engs. Illustrated description of this New York hotel, designed for the accommodation of men who receive low wages. 6000 w. Engr, N. Y.—July 15, 1898. No. 21509.

Post-Office.

The Heating of a Small Post-Office Building. Describes and illustrates an unusual, though simple, system of ventilation and heating. 600 w. Eng Rec—July 16, 1898. No. 21508.

Public Institutions.

The Heating and Sanitation of Public Institutions. W. N. Twelvetrees. A very completely illustrated account of the heating and household arrangements at Brook Hospital near London. 4500 w. Engineering Magazine—August, 1898. No. 21795 B.

Radiators.

A Suggestion for Determining the Heating Surface of Indirect Radiators. H. Eisert. Read at Atlantic City meeting of the Am. Soc. of Heat. & Ven. Engs. Showing that the relative value of a heating surface depends mainly on the arrangement of the surface and its condition, and gives the results obtained by careful study. 2200 w. Heat & Ven—July 15, 1898. No. 21642.

Sanitation.

House Sanitation. Esther A. Pownal. Read at meeting of New Hope Farmers' Inst., Doylestown, Penna. Discusses the heating, lighting and ventilating of a house. 2800 w. San—July, 1898. No. 21351 D.

Ventilation Tests.

Some Accepted Tests of Ventilation—Are They Reliable? T. C. Northcott. Read at the Atlantic City, N. J., meeting of the Am. Soc. of Heat. & Ven. Engs. Discusses the tests for carbonic acid gas, the lime water test, and the anemometer. 1800 w. Met Work—July 23, 1898. No. 21601.

PLUMBING AND GASFITTING.

Cologne, Germany.

Sanitary Experiments at Cologne, Germany. W. M. Watson. Comments on the report of valuable experiments made to thoroughly investigate the whole system of plumbing, and the lessons to be learned from them. 1800 w. Can Engr—July, 1898. No. 21568.

Office Building.

Plumbing Details in the Ivins Building, New York City. Illustrates the general water-supply system and the soil and vent pipes of a very high building. 1300 w. Eng Rec—July 23, 1898. Serial. 1st part. No. 21616.

Pipe Joints.

English Views on Joint Making. W. J.

Maguire. Condensed from Manchester Health Lectures. Gives the practice in making joints connecting lead and iron pipe, and connecting branches with soil pipe. 900 w. San Plumb—July 1, 1898. No. 21378.

Regulations.

Plumbing Regulations in Savannah, Ga. A copy of the ordinance in force in this city. 2200 w. San Plumb—July 1, 1898. No. 21379.

MISCELLANY.

Fireproof.

A New Type of Fireproof Construction. (Un Nouveau Type de Constructions Incombustibles.) Describing the use of expanded metal and cement to form a satisfactory system of fireproof construction. 1200 w. La Revue Technique—June 25, 1898. No. 21700 D.

Glasgow.

The Architecture of Our Large Provincial Towns. Considers the architecture of Glasgow in detail, giving many illustrations and general information. 6400 w. Builder—July 9, 1898. No. 21532 A.

Jubilee.

The Jubilee Exhibition at Vienna, 1898. (Jubiläums-Ausstellung 1898 in Wien.) A gen-

eral plan of the grounds, together with elevation and plan of the pavilion of the three principal commissions. 1800 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—July, 1898. No. 21748 D.

Landscape Architecture.

Landscape Phase of the University of California Plan. Warren H. Manning. Reviews the conditions and requirements of interest to those who have entered the competition for the architectural plan of this university. 2800 w. Am Arch—July 16, 1898. No. 21513.

The Metropolitan Reservations of Boston. Review of the report of Charles Eliot on the treatment of vegetation for scenic effects. 1000 w. Eng Rec—July 16, 1898. No. 21501.

Mortar.

Quality of Mortar. Gives some facts relating to mortar and its use, and the superiority of machine mixed mortar. 1500 w. Br Build—July, 1898. No. 21670 C.

Parks.

Architectural Features of the Boston Parks. Sylvester Baxter. Part first describes the bridge architecture of these parks, which is highly praised. 2200 w. Am Arch—July 16, 1898. Serial. 1st part. No. 21512.

CIVIL ENGINEERING.

BRIDGES.

Abutments.

Concrete Abutments for a Railroad Bridge at Buffalo, N. Y. Describes the interesting features in the rebuilding of the abutments of a bridge of the N. Y. C. R. R. made necessary by the deepening of the Erie Canal. Ill. 1100 w. Eng News—July 21, 1898. No. 21593.

Africa.

An American Bridge for South Africa. Illustrates a bridge recently shipped by an American firm, for the Orange Free State railways. 400 w. R R Gaz—July 29, 1898. No. 21690.

Aqueduct Bridge.

A Steel Aqueduct Bridge. Illustrated explanation of the details of a bridge with an aqueduct 96-ft. long, 53-ft. wide, and 9¾-ft. deep, on the Erie Canal. 800 w. Eng Rec—July 9, 1898. No. 21416.

Arch Truss.

The Surprise Creek Arch. Illustrated description of the design and erection of a 290-ft. pin-connected arch bridge on the Canadian Pacific railway. 1000 w. Eng Rec—July 16, 1898. No. 21503.

Criticism.

A Bridge that Ought to be Better. Illustration and criticism of bridge recently erected across the Cedar River, near Iowa City, Ia. Gives criticisms of J. A. L. Waddell with further explanations. 1400 w. Eng News—June 30, 1898. No. 21249.

Erection.

Bridge Erection by Projection in France.

An explanation of the work. 600 w. Eng Rec—July 16, 1898. No. 21506.

Erection of the Newport and Cincinnati Bridge. Illustrated description of the construction and removal of two sets of false work over nearly 1500-ft. of waterway, the removal of old spans, the erection of two sets of new spans, and the corresponding work on the long approaches of an unusually wide, heavy bridge. 2400 w. Eng Rec—July 23, 1898. No. 21613.

Failure.

Fatal Collapse of a Highway Bridge. Illustrated description of an accident at Shelby, O., on July 4, 1898. 700 w. Eng Rec—July 23, 1898. No. 21614.

Suspension Bridge.

A Historic Bridge. Illustrated description of the first large cantilever trussed bridge, and the manner of erecting it across the Kentucky River. 1200 w. Eng Rec—July 9, 1898. No. 21415.

Swing Bridge.

A Recent Example of Automatic, Interlocking Machinery for Operating a Swing Bridge. Charles H. Wright. Illustrated description of devices used on a long span constructed by the Edge Moor Bridge Works, and their action. 800 w. Eng News—July 7, 1898. No. 21385.

Some Novelties in Swing Bridge Construction on the Trent Valley Canal. R. B. Woodworth. Illustrates and describes peculiarities of construction in two bridges crossing the Trent Valley Canal, Canada. 900 w. Eng News—June 30, 1898. No. 21250.

Viaduct.

The Mungsten Viaduct. (Le Viaduc de

Müngsten.) An illustrated account of this great steel arch, with views of the structure both in course of erection and when completed. 4000 w. 1 plate. *Le Génie Civil*—July 2, 1898. No. 21714 D.

CANALS, RIVERS AND HARBORS.

Anchors.

A Novel Fixed Anchor Construction for Jetties, Buoys and Light Ships. Illustrates and describes the very efficient system of anchors employed in the construction of a small jetty built at Atlantic City, N. J., in 1897. 800 w. *Eng News*—July 7, 1898. No. 21389.

Aqueduct Bridge.

See Civil Engineering, Bridges.

Canal Lift.

The Inclined Plane, as a Canal Lift. (*Die Schiefe Ebene als Schiffs-Hebewerk.*) Victor Schönbach. A discussion of the inclined plane system as a substitute for canal locks, showing the conditions under which it is mechanically and commercially applicable. Describes an improved form. Two articles. 8000 w. *Zeitschr d Oesterr Ing u Arch Ver*—June 17, 24, 1898. No. 21730 each B.

Dam.

The New U. S. Government Needle Dam at Louisa, Ky., on the Big Sandy River. Illustrates and describes the construction and operation. 5400 w. *Engng News*—July 7, 1898. No. 21384.

Docks.

Penarth Docks. Illustrates and describes a clever piece of engineering in connection with the entrance to these docks. 1800 w. *Engng*—July 15, 1898. No. 21633 A.

Dredging.

River and Harbor Dredging. Illustrated description of the sand dredger "Brancker" which was used for the removal of the Mersey Bar. 2400 w. *Ind & East Engr*—June, 1898. No. 21524 D.

Floating Dock.

See Marine Engineering.

Floods.

The High Water Catastrophes of 1897 in Austria. (*Die Hochwasser-Katastrophe des Jahres 1897 in Oesterreich.*) With graphical diagrams showing the drainage areas and rise in the rivers, compared with the rainfall. A valuable study in river hydraulics. 3500 w. 1 plate. *Oesterr Monatschr f d Oeffent Baudienst*—July, 1898. No. 21749 D.

Gauging.

Gauging of Streams. William G. Price. A description of some of the methods of velocity measurements used by the writer, including the use of the current meter and the rod float. Discussion. 6500 w. *Jour W Soc of Engs*—June, 1898. No. 21437 D.

Inter-Oceanic Canal.

An Inter-Oceanic Canal. Presents the need of such a canal in view of recent changes,—the annexation of the Sandwich Islands, &c. Dis-

cusses routes suggested, and the difficulties in the way. 1500 w. *Bankers' Mag*, N. Y.—July, 1898. No. 21443 D.

Jetty.

Jetty Construction on the Pacific Coast. Gwynn A. Lyell. A fully illustrated account of the construction of the successful jetty at the mouth of the Columbia river. 3000 w. *Engineering Magazine*—August, 1898. No. 21792 B.

Lighthouse.

The Electric Lighthouse at Ryvingen, Norway. (*Le Phare Electrique de Ryvingen, Norvège.*) Ch. Delgobe. An illustrated account of this fine new work, with plate showing the arrangement of the lantern and the production of the flashes. 3500 w. 1 plate. *Le Génie Civil*—June 18, 1898. No. 21711 D.

N. Y. Canals.

The New York State Canal Investigation. A full and interesting account of the project to improve the canals, the estimates given, the results of the careful investigation of the Commission appointed by the Governor, &c. 4800 w. *R R Gaz*—July 29, 1898. No. 21688.

Nicaragua.

The Nicaragua Canal. Urging the importance of this work and quoting from the paper by Alfred Noble, published in the *Journal of the Western Society of Engineers*. 2700 w. *Guntton's Mag*—July, 1898. No. 21293 C.

The Nicaragua Canal in its Commercial and Military Aspects. Joseph Nimmo, Jr. An argument against the construction of the canal showing the objections and difficulties in which the project is involved. 3000 w. *Engineering Magazine*—August, 1898. No. 21791 B.

Obstructions.

Obstructive Bridges and Docks in the Chicago River. G. A. M. Liljencrantz. Notes on the various obstructions to navigation found in the Chicago River, considering it as it is, as it will be, and as it might be. Illustrated by sketches. Discussion and correspondence. 11300 w. *Jour W Soc of Engs*—June, 1898. No. 21439 D.

Riparian Rights.

Two Recent Decisions Concerning Riparian Rights. Review of decisions in supreme courts of Maryland and New York upholding riparian owners' rights. 1400 w. *Eng Rec*—July 9, 1898. No. 21420.

Ship Canal.

New Ship Canal Entrance to the Harbor of Duluth, Minn. Improvements demanded by increased size of lake vessels and growth of lake commerce are now in progress. Illustrated description showing location and general dimensions of the old and new piers. 1800 w. *Eng News*—July 28, 1898. No. 21694.

Venice.

The Lagoons of Venice. Giacomo Boni. Discusses the scheme for modernizing Venice, and urging all who have influence to use it in defending her lagoons. Ill. 2500 w. *Jour Roy Inst of Brit Arch'ts*—June 11, 1898. No. 21383 B.

Water Flow.

A New Formula by Bazin for Computing Flow of Water in Open Channels. Brief explanation of the formula and the reason for deducing it. 900 w. Eng News—July 14, 1898. No. 21490.

IRRIGATION.**Artesian.**

Artesian Irrigation. The method of irrigation used in South Dakota, where the supply is obtained from artesian wells, is described. 1100 w. Sci Am—July 23, 1898. No. 21587.

Wells.

Wells and Irrigation. Discussing the sinking of wells in India for irrigation and domestic use, giving arguments advanced in favor of the project, and also the harm liable to follow unless their use and repairs are controlled. 1200 w. Ind Engng—June 25, 1898. No. 21685 D.

MISCELLANY.**Cement.**

Annual Meeting of the Association of German Portland Cement Manufacturers. Abstracted by S. B. Newberry from the Official Report. 2500 w. Eng News—July 7, 1898. No. 21387.

Comparison of Recent Specifications for Fineness and Tensile Strength of Cements. Requirements in specifications for cement, with editorial. 2000 w. Eng News—July 28, 1898. No. 21698.

The Distinction between Slag and Portland Cements. Presents the unfortunate results of selling slag as Portland cements. 1800 w. Eng Rec—July 9, 1898. No. 21417.

The Empire Portland-Cement Plant at Warners, N. Y. Frederick H. Lewis. Illustrated description of a large plant running on the semi-humid process. 1600 w. Eng Rec—July 16, 1898. No. 21502.

The Portland Cement Industry of the World. Bernard L. Green. Reviews the past and present state of the industry in each of the cement-producing countries. Discussion. 10000 w. Jour of Assn of Engng Soc's—June, 1898. No. 21499 C.

Commercial Engineering.

Commercial Aspect of Engineering. Charles E. Larrard. Extracts from a paper read before the South West London Polytechnic Engineering Society. Part first discusses the need of attention in technical instruction to the preparation of estimates and commercial management. 3800 w. Prac Engr—July 8, 1898. Serial. 1st part. No. 21539 A.

Engineering.

A Year's Progress in Engineering. Alphonse Fteley. Slightly condensed from his address at the Detroit meeting of the Am. Soc. of Civ. Engs. Interesting review of railway construction and operation, canals, harbors, water supplies, buildings, tunnel construction, &c. 6800 w. Eng News—July 28, 1898. No. 21699.

Forestry.

Forestry in Relation to Physical Geography and Engineering. John Gifford. Considers

the benefits derived from the forests, other than the value of the wood, and urges the importance of legislation for their protection. Ill. 6000 w. Jour Fr Inst—July, 1898. No. 21298 D.

Hawaii.

Engineering Work in the Hawaiian Islands. Describes the construction of the Nuuanu Pali road, up a steep mountain side, and mentions other engineering work. Ill. 900 w. Eng News—June 30, 1898. No. 21254.

Hydraulics.

Two Graphic Methods Applied to Hydraulic Calculations. Ponsonby Moore Crosthwaite. A comparison of the two methods of plotting diagrams, with an explanation of the principle and the advantages. 1400 w. Engng—July 15, 1898. No. 21632 A.

Italy.

Engineering in Italy. Ettore de Castro. General remarks with an illustrated description of the heating and ventilating plant in the largest hospital in the world—the Policlinic Umberto I^o, in Rome. 2500 w. Power—July, 1898. No. 21364.

Paint Tests.

Tests of Various Paints on the 155th St. Viaduct, New York City. Presents the report of Henry B. Seaman upon the condition of the various paints applied as a preliminary test before repainting the structure. 1000 w. Eng News—July 7, 1898. No. 21388.

Surveying.

Co-ordinate Survey of the City of Boston. Frank O. Whitney. Describes the work of the Board of Survey appointed to devise a scheme of streets for the entire city, as a basis for future street improvements. 8500 w. Jour of Assn of Engng Soc's—June, 1898. No. 21498 C.

Measuring Apparatus, Kings County Survey, N. Y. Samuel McElroy. Describes methods and apparatus used in making this survey. Discussion. 4500 w. Jour W Soc of Eng's—June, 1898. No. 21440 D.

Timber Testing.

Progress in Government Timber Testing. From the annual circular (No. 18) of the forestry division of the department of agriculture, on the investigations made during 1897. Gives briefly the most important conclusions reached, with editorial. 3800 w. Ry & Engng Rev—July 2, 1898. No. 21353.

Progress in Timber Physics. A valuable report of the Division of Forestry of the U. S. Department of Agriculture, giving the results of timber tests, including data about the influence of size of test specimens, and of the distribution of moisture. 15000 w. U. S. Dept of Agriculture, Circular No. 18—January 2, 1898. No. 21776 B.

Relation of Compression Endwise Strength to Breaking Load of Beam. S. T. Neely. From Circular No. 18, Division of Forestry, U. S. Dept. of Agriculture. Data, diagrams and tables, giving information obtained by tests. 2400 w. Ry & Engng Rev—July 9, 1898. No. 21435.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Cotton Spinning.

Profits on Cotton Spinning in Japan and China. A statement of the conditions of this industry which is likely to come into competition with British products. 1500 w. Engng—July 1, 1898. No. 21465 A.

The Cotton Manufacturing Industry in Mexico. Editorial review of this industry in Mexico, and its recent rapid development, showing that the conditions render it very hard for English cottons to compete with them. 2000 w. Engng—July 15, 1898. No. 21636 A.

The Progress of the Cotton Industry in Japan and China. Discussing points relating to progress being made in this industry. 2000 w. Ind & East Engr—June, 1898. No. 21523 D.

Dangers.

Industrial Dangers in England. Calls attention to the changed conditions and the dangers arising from the dissatisfaction of the laboring class. Thinks England is coming to need protection against continental Europe to maintain the wage level. 2500 w. Gunton's Mag—July, 1898. No. 21292 C.

Hawaii.

The Hawaiian Islands. Brief report of their commerce, giving comparative tables of importations for 1896 and 7. 500 w. Bos Jour of Com—July 23, 1898. No. 21606.

Interstate Commerce.

See Railway Affairs, Legal.

Philippines.

Facts about the Philippines. Frank A. Venderlip. Treats of their importance as a base for commercial operations, their products, mineral resources, &c. Ill. 5200 w. Century Mag—Aug., 1898. No. 21683 D.

The Philippine Islands. Frank F. Hilder. An outline sketch of these islands, noting their commercial advantages, natural resources, and their value to the United States. 5500 w. Forum—July, 1898. No. 21294 D.

The Philippine Islands. John A. Osborne. An account of these islands, describing their characteristics, inhabitants, and the value of their products. 2300 w. Chau—July, 1898. No. 21289 C.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Tabulated report with comments on the movement of prices. 3500 w. Bradstreet's—July 9, 1898. No. 21400.

Recent Movement of Prices of Iron Ores, Iron and Steel in Different Countries. Reports output and prices in the most important countries regarding iron-ore, pig-iron, and finished iron and steel. 2200 w. Ir & Coal Trds Rev—June 24, 1898. No. 21333 A.

Rubber Prices.

The Latest Action Regarding Prices. Information concerning the advance in prices of mechanical goods due to the high price of crude

rubber. 1500 w. Ind Rub Wld—Aug. 1, 1898. No. 21801 D.

Some Real Needs of the Rubber Trade. Letter from a manufacturer pointing out some of the difficulties met in regulating prices so as to permit reasonable profits. 1300 w. Ind Rub Wld—Aug. 1, 1898. No. 21802 D.

Rubber Trade-Marks.

Trade-Marks for Mechanical Rubber Goods. List of over 500 trade marks with the firm names. Ind Rub Wld—Aug. 1, 1898. No. 21803 D.

San Jose Scale.

International Relations Disturbed by an Insect. L. O. Howard. On the embargo against American plants and fruits. 2100 w. Forum—July, 1898. No. 21295 D.

Spain.

The Resources and Industries of Spain. Edward D. Jones. Reviews the characteristics of the chief industrial districts of Spain showing their diverse character; the undeveloped state of the commerce; and the many needs of the nation if it is to keep pace with the progress of the world. 3000 w. N Am Rev—July, 1898. No. 21290 D.

United Kingdom.

The Trade and Industries of the United Kingdom in Their Relations to Those of Other Countries. Extracts from a report which the Statistical Department of the Swedish Administration has this year issued on the trade and industries of Great Britain and Ireland in their relation to those of foreign countries, showing that their position continues to compare favorably with any other nation. 2500 w. Col Guard—July 8, 1898. No. 21552 A.

United States.

America Revisited in War Time. Henry Norman. An article very complimentary to the American people, recognizing their mechanical ingenuity and commercial enterprise, and discussing the new conditions likely to arise from the war with Spain. Urges the alliance with England, as advantageous to both nations, and for the advancement of civilization. 4000 w. McClure's Mag—July, 1898. No. 21276.

A Most Remarkable Year's Commerce. Editorial comment on the recently completed record by the Bureau of Statistics, which shows the exports to be twice as great as the imports. 900 w. Bos Jour of Com—July 23, 1898. No. 21605.

Trade Details of a Remarkable Year. Editorial on the record of the foreign trade of the United States in 1897-98. 1000 w. Bradstreet's—July 23, 1898. No. 21607.

CURRENCY AND FINANCE.

Coins.

Values of Foreign Coins and Currencies. Statement covering from Jan. 1, 1874 to April 1, 1898. 1200 w. Cons Repts—June, 1898. No. 21240 D.

Gold Circulation.

Increasing the Circulation of Gold. Alexander

E. Outerbridge, Jr. Urging the circulation of gold among the people, by the issuing of gold coins of denominations suitable for distribution in payment of debts of moderate amounts. 1500 w. Bankers' Mag—July, 1898. No. 21444 D.

GOVERNMENTAL CONTROL.

Eight-Hours' Law.

The United States Supreme Court and the Utah Eight-Hours' Law. Florence Kelley. Reviews the legislation on this subject in various states, and the opinions advanced, and points the importance and lessons of this decision. 5000 w. Am Jour of Soc—July, 1898. No. 21423 D.

LABOR.

Compensation Act.

The Results of a Private Workmen's Compensation Scheme. Particulars given by Mr. George Livesy, regarding the working of his scheme, with editorial. 3000 w. Engr, Lond—June 24, 1898. No. 21328 A.

The Workmen's Compensation Act, 1897. C. S. Ellery. Read at Belfast meeting of the Incorporated Gas Inst. Discusses the liability of the gas industry and how best to meet the claims. Statistical tables of accidents in gas works which seem to indicate that about 3s. per £100 of wages ought to meet the requirements of the act. Discussion. 5600 w. Gas Wld—June 25, 1898. No. 21345 A.

Cost of Labor.

The Cost of Boiler-Room Labor. Extracts from a circular issued by the Mutual Boiler Insurance Co. of Boston, Mass., with remarks. 900 w. Eng News—July 28, 1898. No. 21695.

Machinery.

Does Machinery Displace Labor? C. Wood Davis. Discusses the official statements of Carroll D. Wright, and the effect of machinery on labor, thinking the question worthy of serious consideration. 6500 w. Forum—July, 1898. No. 21297 D.

Relief Organizations.

Brotherhood Relief and Insurance of Railway Employees. Emory R. Johnson. Considers the relief and insurance organizations; the brotherhoods, their plan and organization; the benefit departments, ladies' auxiliaries; the policy and probable future of the work. 17500 w. Bul of Dept of Labor—July, 1898. No. 21619 D.

ELECTRO-CHEMISTRY.

Electrical Industries.

The Electrical Industries of Sault Ste. Marie. F. H. Clerque. Abstract of an address delivered before the Northwestern Elec. Assn. Most of the industries considered are electro-metalurgical processes. 1800. Elec Wld—July 2, 1898. No. 21363.

Electrolysis.

The Carlln Tube. A. von Dessauer. De-

Statistics.

Contemporary Labor. (Le Travail Contemporain.) Col. Fix. A comparison of labor statistics, in various parts of Europe, in connection with the development of various lines of industry. Serial. 1st part. 3000 w. La Revue Technique—June 25, 1898. No. 21705 D.

Steel Trade.

Conciliation in the Steel Trade. Editorial giving particulars concerning the methods used by the Board of Conciliation and Arbitration for the Manufactured Steel Trade of the West of Scotland. 1000 w. Engng—June, 24, 1898. No. 21324 A.

MISCELLANY.

Baths.

Public Baths. (Volksbäder.) A general account of the various kinds of public baths, and a plea for their wider introduction in Germany. The providing of baths is held to be as much of a public duty as that of general water supply. 3500 w. Gesundheits-Ingenieur—June 30, 1898. No. 21743 B.

Cotton Industry.

Effect of the Cotton Spinning Industry in China upon the Kindred Industry in India. Walter C. Wood. A comparison of the basis upon which this industry is conducted in both countries; also comparing climates, mills, machinery, people, &c. 4800 w. Jour Soc of Arts—June 24, 1898. No. 21339 A.

The Depression in the Cotton Industry: A Remedy. Luther F. McKinney. Considers the depression of the cotton industry to be due to over production, and that the remedy is a wider market. Thinks a large share of the trade of South America should be secured and suggests means. 2400 w. Forum—July, 1898. No. 21296 D.

Cuba.

Cuba's Wealth to be Expanded. Bradley T. Johnson. Opportunities for enterprise when the island is under stable government. 1800 w. Mfrs Rec—July 8, 1898. No. 21390.

Exposition.

Universal Exposition of 1900. (Exposition Universelle de 1900.) A review of the present condition of affairs, including the various systems proposed for the transportation of visitors within the exposition grounds. 4000 w. La Revue Technique—June 25, 1898. No. 21703 D.

ELECTRICAL ENGINEERING.

scribes a new connection for anodes and cathodes and states the advantages. 1500 w. Jour of Chem & Met Soc of S Africa—May, 1898. No. 21656 E.

Electroplating.

Electroplating on Wood. C. F. Burgess. Describes a process by means of which a metallic surface on wood and other non-conducting materials has been obtained. 2000 w. Elec Wld—July 30, 1898. No. 21673.

Polarization.

A Simple Method for the Determination of Polarization. (Eine Einfache Methode zur Bestimmung der Polarisirung.) Dr. Heim. Describing a method which involves the comparison of results obtained by measuring the voltage with two and with three electrode plates; the subject is discussed at length and practical examples given. 3500 w. Zeitschr f Elektrochemie—June 5, 1898. No. 21767 H.

Refining.

Some Notes on the Electrolytic Refining of Tin and the Recovery of Tin from Its Ores. Sherard Cowper-Coles. Describes methods which have been tried, and the results obtained. 900 w. Elec Engr, Lond—July 15, 1898. No. 21650 A.

See Mining and Metallurgy, Copper.

LIGHTING.**Arc.**

The Electric Arc. (Ueber den Elektrischen Lichtbogen.) W. Mathiesen. A general account of the electric arc considered independently of any especial lamp mechanism, including the use of electrodes of various materials. 2500 w. Die Elektrizität—June 11, 1898. No. 21768 B.

Arc Lighting.

A Few Interesting Pointers Concerning Enclosed Arc Lighting. J. H. Hallberg. Notes causes of trouble and calls attention to the advantage of having the men who sell, install, and care for these lamps more familiar with the mechanical and electrical details. 2800 w. Elec Eng, N. Y.—July 14, 1898. No. 21445.

Central Station.

A Modern Electric Central Station. George A. Damon. Illustrated detailed description of the plant of the Imperial Electric Light, Heat and Power Company, of St. Louis, Missouri, given as showing the latest solution of the problem of the generation and distribution of electrical energy. 5000 w. Trans of Am Inst of Elec Engs—May, 1898. No. 21287 D.

How to Overcome Some of the Difficulties Encountered by Central Station Men. A. A. Wright. Read at meeting of Can. Elec. Assn. Deals with street lighting, commercial lights, incandescent service, meters, &c. Discussion. 2500 w. Can Elec News—July, 1898. No. 21561.

The Edison Central Station at Paris, France. L. Bayly. Brief detailed description. 1000 w. Elec Rev, N. Y.—July 6, 1898. No. 21381.

Distributing Systems.

Two-Wire Distributing Systems and Lamps, 200-240 volts. John W. Howell. Presents the advantages over the three wire system, and discusses the system in detail. 2300 w. Trans of Am Inst of Elec Engs—May, 1898. No. 21278 D.

Edinburgh.

The Electric Lighting of Edinburgh. Frank A. Newington. Read at meeting of the Incorporated Assn. of Munic. and County Engrs. Detailed description. 2300 w. Elec Eng, Lond—July 8, 1898. No. 21535 A.

Exposition.

The Lighting of the Trans-Mississippi Exposition. Illustrates and describes the extensive electrical illumination. 800 w. Elec Wld—July 9, 1898. No. 21401.

The Trans-Mississippi and International Exposition. An illustrated account of some of the electrical features of the Omaha fair, and the effects of the illumination. 1800 w. Elec Rev, N. Y.—July 20, 1898. No. 21569.

Glasgow.

The Glasgow, Scotland, Municipal Lighting Plant, Port Dundas. Illustrates and describes a plant which will contain a great deal of American apparatus. 800 w. Elec Eng, N. Y.—July 21, 1898. No. 21573.

High Pressure.

Installations for Operation at a Pressure of 250 Volts. (Ueber Installationen für eine Gebrauchsspannung von 250 volt.) Dr. Passavant. A general description of the details of the 250-volt lighting system as used by the German General Electric Company. 4000 w. Elektrotech Zeitschr—July 7, 1898. No. 21764 B.

Illumination.

The Importance of Proper Methods of Illumination. F. A. Bowman. Read at meeting of Can. Elec. Assn. Discusses means of increasing illumination, and the necessity of trying to please customers, if competition is successfully met, and points to this end. 2500 w. Can Elec News—July, 1898. No. 21562.

Meter Tests.

Notes on Some Central Station Meter Tests. William D. Ennis. Reports of recent test of the meter system of a small lighting and power station near New York, with recommendations adopted. 1400 w. Elec Eng, N. Y.—July 7, 1898. No. 21428.

Morley.

Morley Electric Lighting Works. Illustrated description of an English plant. 2500 w. Elec Rev, Lond—July 15, 1898. No. 21649 A.

Regulation.

An Electro Magnetic Regulating System for Arc Lamps. (Ueber Schaltungen von Regelungen elektromagneten bei Bogenlampen.) Th. Weil. Description of an improved arc lamp regulator; with mathematical discussion of the action of the regulating magnets. 3000 w. Elektrotech Zeitschr—June 30, 1898. No. 21762 B.

Pressure Regulator for Alternating Plants. (Fernspannungsregulierung in Wechselstrom Anlagen.) G. W. Meyer. Describing a system of maintaining a constant pressure over an extended area, for an alternating incandescent lighting system. 2500 w. Elektrotech Rundschau—June 15, 1898. No. 21769 B.

Switchboard.

Home Station Switchboard for Toll-line Systems. H. P. Clausen. Illustrated description. 1.00 w. W Elect'n—July 23, 1898. No. 21603.

Vacuum Tubes.

Vacuum Tube Lighting. Reviews the early

development of this form of lighting and describes and illustrates the system. 2500 w. Pro Age—July 1, 1898. No. 21273.

Wakefield.

Wakefield Corporation Electricity Works. Description of an English plant. 3000 w. Elec Rev, Lond—July 8, 1898. No. 21537 A.

Winchester.

Winchester Electric Lighting. Illustrates and describes this English plant. 1400 w. Elec Eng, Lond—July 8, 1898. No. 21534 A.

Wiring.

Changes in Electric Wiring. Harry N. Gardner. Discusses methods which have been in favor but are now considered unsafe; also the methods now in favor. 2500 w. Am Elect'n—July, 1898. No. 21372.

POWER.

Alternating Currents.

The Graphical Treatment of Alternating Currents in Branching Circuits, with Special Reference to the Case of Variable Frequency. Henry T. Eddy. Considers general and special cases. 9000 w. Trans of Am Inst of Elec Eng—May, 1898. No. 21288 D.

See Street and Electric Tramways.

The Commutated Current Wave of a Composite-Wound Alternator. Dugald C. Jackson. Presents a series of curves with comments. 450 w. Trans of Am Inst of Elec Eng—May, 1898. No. 21284 D.

Commercial Plant.

The Technical Arrangements at the Wertheim Stores at Berlin. (Die Technischen Einrichtungen des Warenhauses der Firma A. Wertheim zu Berlin.) A general description of the mechanical installation of a great department store, including power plant, electric lighting, elevators, &c., &c. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—July 2, 1898. No. 21738 each D.

Dynamos.

Sayers' Automatic Third-Brush Regulation of Dynamos. Describes the arrangement and gives results of some experiments. 500 w. Elect'n, Lond—July 8, 1898. No. 21531 A.

Economical Power.

Economy in Power Installations. Abstract by Charles Weiss from an article in the *Zeitschrift für Elektrochemie*. On the most economical source of energy for central stations. Considers water, steam and gas, but gives comparative costs of the last two named. 2500 w. Engng—July 8, 1898. No. 21545 A.

Electric Power.

See Railway Affairs, Motive Power.

Electric Pump.

See Mining and Metallurgy—Mining.

Exposition.

Electric Service Plant at the Trans-Mississippi and International Exposition. Illustrated description of the plant that furnishes current for the illumination of the grounds and buildings and the operation of motors. 2000 w. W Elect'n—July 23, 1898. No. 21602.

Glasgow.

Electric Power Station at Port Dundas, Glasgow. Plan, cross-section, and front elevation, with description. 1000 w. Engng—June 24, 1898. No. 21323 A.

Hydraulic Plant.

Electric Utilization of Water Powers. L. D. W. Magie. Abstract of a paper read before the Canadian Elec. Assn., at Montreal, Que. Discusses questions requiring study in the harnessing of water powers; also the cost. 1500 w. Elec Wld—July 9, 1898. No. 21403.

Lachine Rapids Plant and the Cost of Producing Power for Generating Electricity Therefrom. W. M'Lea Walbank. A detailed statement of costs, with editorial comment. 2500 w. Elect'n, Lond—July 8, 1898. No. 21530 A.

The Electric Plant of the City of Schaffhausen. (Das Elektrizitätswerk der Stadt Schaffhausen.) K. P. Täuber. A very complete and fully illustrated account of the hydraulic power and electric plant above the Falls of the Rhine. Three articles. 5000 w. Schweizerische Bauzeitung—June 4, 11, 18, 1898. No. 21739 each B.

The "Soo" Water Power. Illustrated description of a plant to develop 40,000 h. p. at Sault Ste. Marie, Mich. 2400 w. Eng Rec—July 23, 1898. No. 21615.

The Utilization of the Falls of Kerka, in Dalmatia. (Project zur Verwerthung der Wasserkraft der Kerkafälle in Dalmatien.) G. Sartori. A detailed description of the hydraulic and electric plant designed to utilize over 7000 h. p. from the river Kerka, near Sebenico, in Dalmatia. Two articles. 3000 w. Electro-Techniker—May 31, June 15, 1898. No. 21770 each B.

Isolated Plants.

Some New Isolated Plants. Part first illustrates and describes some of the plants recently installed in New York, including the Exchange Court Building, Washington Life Ins. Bldg., Cushman Bldg., and Singer Bldg. 3300 w. Elec Wld—July 30, 1898. Serial. 1st part. No. 21672.

Motor.

Economy of a 600-Horse-Power Electric Motor. Describes the remarkable work accomplished by the motor which moves the cable trains on the south side of the city of Chicago. 900 w. Bos Jour of Com—July 2, 1898. No. 21313.

Some Notes on the Practical Use of Single-Phase Alternating Motors. E. E. Hoadley. Facts about the behavior of alternating motors under actual working conditions. 2500 w. Elec Rev, Lond—July 8, 1898. No. 21538 A.

Niagara.

New Work at Niagara Falls by the Hydraulic Company. Orrin E. Dunlap. Illustrates and describes the recent extension of the company's plant. 2000 w. Elec Eng, N. Y.—July 28, 1898. No. 21660.

Power Applications.

Electric Power in Meat-Dressing Establishments. Describes two plants installed in packing houses at St. Joseph, Mo. Ill. 1600 w. W Elect'n—July 16, 1898. No. 21510.

Prague.

Electric Power Station at Laun near Prague. (Elektrische Kraftvertheilungsanlage zu Laun bei Prague). A very full account of the plant at the Government Railway Shops, including electric cranes, transfer table, hoists, &c, with many illustrations. 2500 w. *Elektrotech Zeitschr*—June 23, 1898. No. 21758 B.

Pumps.

On the Electrical Operation of Conoidal Centrifugal Pumps. John Richards. Read before the Pacific Coast Electric Transmission Assn. Presenting the advantages and disadvantages met, and showing that the latter may be removed. 2400 w. *Jour of Elec*—July, 1898. No. 21654.

Rolling Mills.

See Mining and Metallurgy, Iron and Steel.

Standardization.

Preliminary Report of the Committee on Standardization. Report submitted for criticism, not yet officially adopted. 5000 w. *Trans of Am Inst of Elec Eng*s—May, 1898. No. 21282 D.

Supply Works.

Morley Corporation Electric Supply Works. Illustrated detailed description of an English plant, with brief history of the undertaking. 3000 w. *Elect'n, Lond*—July 1, 1898. No. 21451 A.

Towing.

The Development of Electric Canal Towing. (Die Entwicklung der Elektrischen Schiffs-tauerei.) H. Cox. An illustrated review of the various methods which have been tried for propelling canal boats by electric power. 3500 w. *Zeitschr d Ver Deutscher Ing*—June 18, 1898. No. 21733 D.

Testing.

Commercial Dynamo and Motor Testing. W. H. Radcliffe. Illustrates and describes methods of testing. 2000 w. *Am Elect'n*—July, 1898. No. 21370.

Some Tests with an Induction Generator. A. F. McKissick. Tests of an induction motor acting as a generator, driven by a direct-current motor are given, with curves showing the operation. 2400 w. *Trans of Am Inst of Elec Eng*s—May, 1898. No. 21285 D.

Transmission.

A Fourteen Mile Transmission at Barton, Vt., with Monocyclic Apparatus. Illustrated detailed description. 1100 w. *Elec Eng, N. Y.*—July 21, 1898. No. 21572.

The Cataract Power Company's Transmission Plant. Illustrates and describes a plant for furnishing electric light and power on a large scale at any point on the line from St. Catharines to Hamilton, Ont. 800 w. *Elec Wld*—July 2, 1898. No. 21361.

TELEGRAPHY AND TELEPHONY.**Baltimore, Md.**

The Chesapeake and Potomac Telephone Company, Baltimore, Md. C. B. Fairchild. History of this company, description of equipment, with rules for governing operators. 2500

w. *Elec Eng, N. Y.*—July 14, 1898. No. 21446.

British Columbia.

The Telegraph in British Columbia. R. B. McMicking. Historical account of the introduction of the telegraph into this province, in connection with the undertaking to connect the old and new world by way of Behring's Strait. 1000 w. *Can Elec News*—July, 1898. No. 21564.

Central Office.

The Central Office. Dr. V. Wietlisbach. A chapter from the writer's work on "Telephony." Illustrates and describes the apparatus used, in a system which has successfully stood the test of service and is in general use for small offices. 2200 w. *Elec Engng*—July, 1898. No. 21425.

The Central-Office Equipment of a Successful Independent Telephone Company. H. P. Clausen. Brief illustrated description of a complete exchange system at Wilmington, Del. 2400 w. *W Elect'n*—July 2, 1898. No. 21373.

Germany.

The Development of the Telephone System of the Imperial Postal Jurisdiction, including Bavaria and Württemberg. (Entwicklung der Allgemeinen Fernsprechanlagen in Reichs-Postgebiet sowie in Bayern und Württemberg.) A very complete tabulated account of the German telephone system, with map of the empire, showing the extent and nature of the connections very clearly. 6000 w. *Elektrotech Zeitschr*—June 9, 1898. No. 21753 B.

High Speed.

High Speed Telegraph Transmission by means of Alternators. Describes the system suggested by A. C. Crehore and G. O. Squire, called the "synchronograph" system, which has been found to produce a distinct increase of speed. 2000 w. *Nature*—June 30, 1898. No. 21447 A.

Lightning.

Lightning Arresters. A. J. Wurts. Abstract of an address before the Northwestern Elec. Assn. Discusses the power of protection from lightning, considering especially two types of arresters. 2000 w. *Elec Wld*—July 2, 1898. No. 21362.

Line Signals.

The Evolution of the Line Signal. Arthur Vaughn Abbott. An illustrated account of the progress on lines of telephonic communication, discussing the devices used, and the value of luminous signals. 4500 w. *Trans of Am Inst of Eng*s—May, 1898. No. 21286 D.

Service.

Telephone Service. Dr. V. Wietlisbach. To form a chapter in the writer's work on "Telephony." Suggestions that may be utilized as a basis for rules meeting local conditions. 1600 w. *Elec Engng*—July, 1898. No. 21426.

Space Telegraphy.

Wireless Telegraphy. Gerald Molloy. An account of Signor Marconi's apparatus and its workings. 1300 w. *Ind Engng*—June 11, 1898. No. 21495 D.

Teleelectroscope.

The Szczepanik Teleelectroscope. An account of this invention, with diagrams, as given in the *N. Y. Herald*. An apparatus for the transmission of scenes and pictures over a wire. 1700 w. *Elec Eng*, N. Y.—July 7, 1898. No. 21429.

The "Teleelectroscope" and the Problem of Electrical Vision. Gives the facts made public in regard to the invention of Jan Szczepanik. Ill. 2000 w. *Sci Am Sup*—July 30, 1898. No. 21681.

Telephone Call.

General Telephone System with Individual Calls. (Einrichtung für Gemeinschaftliche Fernsprecheleitungen mit Getrenntem Anruf der Einzelnen Theilnehmer.) A system by which a number of individuals may use the same telephone wires and call each other or the central station. 4500 w. *Elektrotech Zeitschr*—June 16, 1898. No. 21757 B.

MISCELLANY.**Analyzer.**

An Harmonic Analyzer. J. N. Le Conte. Describes the instrument and its use. Ill. 1000 w. *Phys Rev*—July, 1898. No. 21626 D.

Brush Holders.

Some Modern Brush Holders. Illustrated descriptions of various designs. 2400 w. *Elec Wld*—July 23, 1898. No. 21578.

Condensers.

Experiments on Induction Coil Condensers. Alfred G. Dell. Describes apparatus used and reports experiments made to determine the relation between an induction coil and its condenser. 800 w. *Elec Rev*, N. Y.—July 20, 1898. No. 21570.

Conductors.

A Simple Method of Determining the Most Efficient Cross Section and the Loss in Electrical Conductors. (Eine Einfache Methode zur Bestimmung des Wirthschaftlichen Querschnittes und Arbeitsverlustes für Elektrische Leitungen.) A. Bull. A mathematical treatment, resulting in practical working equations from which the most economical cross section for any given conditions may be found. 2000 w. *Elektrotech Zeitschr*—June 9, 1898. No. 21751 B.

Underground Conductors. F. A. C. Perrine. Describes the systems of underground construction which have been used, showing a very satisfactory development for the large cities. Ill. 7800 w. *Elec Engng*—July, 1898. No. 21424.

Diagrams.

Proposed Standard Diagrams of Electrical Apparatus. Andrew Jamieson. Suggestions for improvement in the figures proposed in American papers, and showing the diversity between American, British and Continental practice. 900 w. *Elec Rev*, Lond—June 24, 1898. No. 21349 A.

Dielectrics.

Dielectric Strength of Air. Charles Proteus Steinmetz. A report of tests made to investi-

gate this subject, describing methods and giving results. 7500 w. *Trans of Am Inst of Elec Engs*—May, 1898. No. 21277 D.

Electrical Development.

The Present Status of Electrical Engineering. A. E. Kennelly. Inaugural address presented at the General Meeting of the American Institute of Electrical Engineers 3000 w. *Elec Wld*—July 9, 1898. No. 21402.

Electrical Discharges.

Disruptive Discharges, Leakage, and Ohmic Resistance. Alex. Jay Wurts. Observations and experience of the writer, with experiments and conclusions. 1700 w. *Elec Wld*—July 23, 1898. No. 21579.

Electrical Discharge from the Point of View of the Kinetic Theory of Matter. J. E. Moore. Part I, presented to the Faculty of Princeton Univ. for the degree of Doctor of Science. Considers some notions concerning the elementary nature of electrical discharge in gases, which are almost wholly dependent upon the kinetic theory of matter. Ill. 7500 w. *Am Jour of Sci*—July, 1898. No. 21256 D.

Electrodes.

Aluminum as an Electrode in Cells for Direct and Alternate Currents. E. Wilson. Read before the Royal Society. Deals with the great apparent resistance which aluminum offers to the passage of an electric current when used as an anode in cells containing such an electrolyte as alum in water. 1600 w. *Elec Eng*, Lond—July 15, 1898. Serial. 1st part. No. 21651 A.

Electrometer.

A Capillary Electrometer for Electrical Measurements. Charles Frederick Burgess. Gives a description of a form of this instrument, enumerating some of its principal characteristics, and calling attention to its applicability for practical electrical measurements. 3500 w. *Trans of Am Inst of Elec Engs*—May, 1898. No. 21279 D.

France.

Electrical Engineering in France. Edward Conner. Calls attention to the application of electricity to mining purposes in this country. 1500 w. *Elec*, Lond—July 8, 1898. No. 21521 A.

Galvanic Element.

The Mechanics of the Galvanic Element. (Die Mechanik des Galvanischen Elementes). J. F. Weydl. An attempt to explain the action by the mechanical conception of whirling molecules. Two articles. 3500 w. *Elektrotech Zeitschr*—June 9, 16, 1898. No. 21752 each B.

Galvanometry.

Ballistic Galvanometry with a Counter-Twisted Torsion System. C. Barus. Explains the use of the ballistic galvanometer by the writer, in a way somewhat different from the ordinary and states the advantages. 1800 w. *Phys Rev*—July, 1898. No. 21624 D.

High Potentials.

Random Notes on Extremely High Potentials. Leon W. Bly. Observations on extreme high potential workings, discussing the difficul-

ties with transformers and the line. 3500 w. Jour of Elec—July, 1898. No. 21653.

Indicator.

An Indicator for Magnetic Rotating Fields and for Alternating Pressures. (Ein Indikator für Magnetischer Drehfelder und für Wechselstromspannungen.) H. Ebert and M. W. Hoffman. A description of an instrument depending for its action upon the effect of magnetic fields upon cathode rays. 2000 w. Elektrotech Zeitschr—June 23, 1898. No. 21759 B.

Induction Coil.

A Quantitative Study of the High Frequency Induction Coil. W. P. Boynton. A discussion of the mathematical theory with description of experiments made to verify the agreement of the actual behavior of an oscillating system with two degrees of freedom with the approximate theory. 5000 w. Phys Rev—July, 1898. No. 21627 D.

Induction Curves.

A Proposal for Uniformity in the Arrangement of Induction Curves. (Vorschläge zur Einheitlichen Darstellung von Induktionskurven.) Dr. H. Kath. Suggesting the desirability of a uniform system, and advocating that of Siemens & Halske. 600 w. Elektrotech Zeitschr—June 23, 1898. No. 21760 B.

Insulated Wire.

Specifications for Insulated Wire for the Navy. General specifications applying to lighting wire, bell wire and cable. 1600 w. Ind Rub Wld—Aug. 1, 1898. No. 21800 D.

Interrupters.

Rapid Interrupters for Induction Coils. C. Margot, in *La Nature*. Illustrated description of two forms of interrupters. 1000 w. Sci Am Sup—July 2, 1898. No. 21259.

Joint Tests.

Joint Test; Supplement to Raymond Barker's Accumulation Mill Method. A. D. Constable. Investigations made on this method with a view to determining whether in all cases it would prove a satisfactory test. Ill. 1400 w. Elec Rev, Lond—July 8, 1898. No. 21536 A.

Liquid Oxygen.

On the Magnetic Susceptibility of Liquid Oxygen. J. A. Fleming and James Dewar. Read before the Royal Society. Gives results of experiments on the magnetic susceptibility under magnetizing forces varying from 500 to 2500 C. G. S. units. 1400 w. Elect'n, Lond—July 1, 1898. Serial. 1st part. No. 21452 A.

Magnetic Disturbances.

See Street and Electric Tramways.

Magnetic Testing.

A New Magnetic Device of Messrs. Siemens & Halske. (Ein Neuer Magnetisirungs-Apparat der Firma Siemens & Halske.) Dr. H. Kath. A fully illustrated account of a new device for measuring the magnetic character of iron. 3500 w. Elektrotech Zeitschr—June 23, 1898. No. 21761 B.

The Siemens and Halske Magnetic Testing Apparatus. Dr. Hubert Kath. An abstract in English of the above paper. 1400 w. Elec Wld—July 30, 1898. No. 21674.

Magnetization.

An Application of Interference Methods to a Study of the Changes Produced in Metals by Magnetization. J. S. Stevens. Investigations with tabulated results and explanation. 1500 w. Phys Rev—July, 1898. No. 21625 D.

Measurement.

The Direct Measurement of a Quantity of Electricity in Electromagnetic Units. (Sur la Mesure Direct d'une Quantite d'Electricite en Unites Electromagnetiques.) A communication to the French Academy by M. Blondlot, with suggestions as to the construction of an electric meter. 1200 w. Comptes Rendus—June 13, 1898. No. 21723 D.

Ozone.

An Ozonizer for Industrial Purposes. (Un Ozoniseur pour les Applications Industrielles.) E. Andreoli. The apparatus consists of plates studded with sharp points between which the electric discharges take place, a pressure of 3000 volts is used. 3500 w. Electricien—June 11, 1898. No. 21771 B.

Radiography.

An Excursion into the Domain of the X-rays. (Streifzüge durch das Gebiet der X Strahlen.) Dr. Kalischer. A general description of the phenomena of radiography, describing the apparatus and effects. Serial. 1st part. 3000 w. Elektrotech Zeitschr—June 16, 1898. No. 21756 B.

Resistances.

Metallic Resistances. Kilburn Scott. Tables giving resistance, weight, current-carrying capacity, size of mandril, &c., of various alloys suitable for resistance frames and of Hadfield's "Resista," with notes, are given in part first. 1200 w. Elec Rev, Lond—July 15, 1898. Serial. 1st part. No. 21648 A.

On the Bridge Method of Comparing Low Resistances. H. L. Callendar. Some remarks on this method and its great advantage, with illustration of its capabilities. 1200 w. Elect'n, Lond—July 8, 1898. No. 21529 A.

The Electrical Resistance of Steel. (Sur la Resistance Electrique des Aciers.) A communication by M. Le Chatelier, showing the respective influences of carbon, silicon, manganese, nickel, chromium, tungsten and molybdenum upon the resistance of steel. 1000 w. Comptes Rendus—June 13, 1898. No. 21724 D.

The Influence of Tempering upon the Electric Resistance of Steel. (Influe de la Trempe sur la Resistance Electrique de l'Acier.) A paper by M. Le Chatelier, showing the effect of tempering at various temperatures, both with and without the presence of other substances than carbon. 1000 w. Comptes Rendus—June 20, 1898. No. 21725 D.

Shielding.

Applications of Electromagnetic and Mechanical Shield Action. (Anwendungen Elektromagnetischer und Mechanischer Schirmwirkung.) H. du Bois. A mathematical discussion, with illustrations showing the shielding effect of various devices as indicated by iron filing figures. 3500 w. Elektrotech Zeitschr—June 16, 1898. No. 21755 B.

Specifications.

Electrical Engineers' Specifications. J. Alec. McLaren. Read before the Yorkshire College Engng. Soc. Considers some of the features of interest. Part first discusses penalties, terms of payment, cost of tendering and manufacture, and boilers. 3500 w. Engr, Lond—July 8, 1898. Serial. 1st part. No. 21557 A.

Statistics.

Statistics of Electric Plants in Germany. (Statistik der Elektrizitätswerke Deutschland.) An editorial accompanied by very full tables giving valuable data for 388 separate plants up to March 1. 12000 w. Elektrotech Zeitschr—July 7, 1898. No. 21763 B.

Temperatures.

The Chemistry of High Temperatures. Report of the Franklin Institute through its committee on Sciences and the Arts, on the investigations of M. Henri Moissan, with the electric furnace. 2000 w. Jour Fr Inst—July, 1898. No. 21303 D.

Transformers.

Alternating Current Transformers.—From the Station Manager's Viewpoint. W. F. White. Presents some results obtained by a plant in remodeling its transformer system, by using a secondary network, fed by large transformers working in multiple, but located one at each centre of distribution, noting some advantages of the change. 3000 w. Trans of Am Inst of Elec Eng—May, 1898. No. 21280 D.

Design, Construction and Test of a 21-2 K. W. Three-Phase, Two-Phase Transformer. A.

F. McKissick. Describes work done by T. G. Connor and B. S. Patrick, under the direction of the writer to determine how far theory dictated correct practice. 1200 w. Am Elect'n—July, 1898. No. 21371.

The Construction of a 150,000 Volt Transformer. Ellery B. Paine and Harry E. Gough. A short description of this piece of apparatus designed and constructed as a subject for post-graduate thesis work at the Worcester Polytechnic Inst. Ill. 1500 w. Elec Wld—July 16, 1898. No. 21470.

The Transformation of Alternating Currents. (Sur le Redressement des Courants Alternatifs.) M. P. Janet. A mathematical discussion of the transformation of an alternating into a continuous current. 1000 w. Comptes Rendus—June 20, 1898. No. 21726 D.

Vacuum Tubes.

On the Relation between Pressure, Current, and Luminosity of the Spectra of Pure Gases in Vacuum Tubes. Ervin S. Ferry. Investigations for the purpose of studying photometrically the changes produced in the spectra of pure gases when subjected to various conditions of current and pressure. 1800 w. Phys Rev—July, 1898. No. 21623 D.

Watt Meter.

A Rapid Verification of the Correctness of the Indications of a Watt Meter. (Vérification Rapide l'Exactitude des Indications d'un Watt mètre.) M. Aliamet. Intended to enable the correction factor to be obtained for a watt meter which has already been calibrated. 2000 w. Electricien—June 18, 1898. No. 21772 B.

MARINE ENGINEERING.**Anchors.**

See Civil Engineering, Harbors.

Chains.

The Wear of Chains. R. Weatherburn. Considers the wear attending the use of chains and the cause. 2800 w. Engr, Lond—July 8, 1898. No. 21555 A.

Disasters.

Responsibility of Steamship Companies in Marine Disasters. Dr. C. E. de M. Sajous. Criticism, called out by the "Bourgogne" disaster, concerning the lack of life-saving appliances furnished, and the causes that hasten the sinking of vessels. 1200 w. Sci Am—July 23, 1898. No. 21583.

Safety at Sea. Editorial on the Bourgogne disaster, and the lessons to be learned by it. 2500 w. Engng—July 15, 1898. No. 21635 A.

The Prevention of Steamship Collisions. Editorial on the disaster to the steamer "La Bourgogne," criticizing the speed maintained in fogs, and suggesting the improvement of sound signals, and the immediate slackening of speed when signal is heard. 3000 w. Eng News—July 14, 1898. No. 21489.

Fire Boat.

Fire Boat "Robert A. Van Wyck" for the City

of New York. Illustrated detailed description. 1200 w. Marine Engng—July, 1898. No. 21314 C.

Floating Dock.

Proposed United States Naval Floating Dock to be Located at New Orleans. Gives a brief history of the development of this form of dock, merely mentioning the appropriation of the U. S. Congress for the construction of a steel floating and graving dock to be located at Louisiana. Ill. 1500 w. Marine Engng—July, 1898. No. 21316 C.

Kaiser Friedrich.

Concerning the New North German Lloyd Liner Kaiser Friedrich. Notes some of the dimensions and chief characteristics of this ship, and examines the cause of her failing to make a record on her maiden voyage. 1600 w. Marine Engng—July, 1898. No. 21318 C.

Launch.

Coaching Launch Used by the Cornell University Rowing Club. Illustrated description with statement of the requirements of a launch for this use. 1000 w. Marine Engng—July 2, 1898. No. 21317 C.

Metal Coatings.

Experiments upon the Durability of Different Metal Coatings Immersed in Sea Water. An

account of the tests made at the Brooklyn Navy Yard, with table showing the results of protective coatings applied to steel and aluminum plates immersed for 13 months. 1500 w. Eng News—July 28, 1898. No. 21697.

Repairs.

Marine Engine Repairs Discussed in a thoroughly Practical Way. J. Kyles. From a paper read before the Inst. of Eng. and Shipbuilders of Hong Kong. Details are discussed and general suggestions given. 4800 w. Marine Engng—July, 1898. No. 21315 c.

Small Craft.

Determination of the Power, Diameter and Pitch of Screws to Propel Small Boats. Facts on these points furnished by a high authority on the subject. The data concerning screws gives the results of recent experimental work. 2000 w. Am Elect'n—July, 1898. No. 21369.

Steamboat.

The New Steamboat Ontegra. Illustrates and describes a new vessel that recently made its first trip on the Hudson River from New York to Catskill. 1800 w. Sea—July 7, 1898. No. 21431.

Steamers.

The New French Steamers for the Channel Service. Illustrated description of the new high-speed steamers for the Channel service, owned by the Northern Railway of France, with a

résumé of the conditions under which this company has obtained the contract for conveying the mails between France and England. 2000 w. Engng—June 24, 1898. No. 21322 A.

Turbinia.

The Fastest Vessel Afloat. Cleveland Moffett. An account of the "Turbinia" from personal observation, with discussion of the effect on ocean travel. Ill. 5000 w. McClure's Mag—July, 1898. No. 21269.

Vibration.

The Vibration of Vessels and the Balancing of Marine Engines. (Des Vibrations des Navires et de l'Equilibre des Machines Marines.) M. Haas. A very valuable and complete mathematical and practical discussion of the nature of vibrations in ships and the extent and manner to which they may be diminished by counterbalancing. Two articles, 10000 w. Revue de Mécanique—April, June, 1898. No. 21729 each H.

Yachts.

The High-Speed Steam Yacht as a Factor in Torpedo Boat Design. W. P. Stephens. The concluding article describes and illustrates the swiftest modern steam yachts, and discusses their peculiar features in comparison with torpedo-boat construction. 3500 w. Engineering Magazine—August, 1898. No. 21797 B.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Cost of Labor.

See Economics and Industry, Labor.

Explosion.

Boiler Explosion in an Oil Mill. Illustrates and describes an explosion which shows that repairs were made on a wrong principle. 800 w. Locomotive—June, 1898. No. 21608.

Furnaces.

Boiler Furnaces for Steam Power Installations. M. C. Huyett. Read at Atlantic City meeting of the Am. Soc. of Heat and Ven. Eng. Also discussion. Gives some fuel data as a basis for the discussion of mechanical smokeless furnaces. 2200 w. Heat & Ven—July 15, 1898. No. 21641.

Grate Surface, Chimney Section and Height for Various Fuels. (Rostflächen, Querschnitte und Höhen der Schornsteine für Verschiedene Brennstoffe.) Max Knorr. A discussion with formulas and tables from which the dimensions of parts may be obtained for hard and soft coal, lignite, coke, peat and wood. 3000 w. Gesundheits-Ingenieur—June 30, 1898. No. 21742 B.

Heat Transmission.

The Transmission of Heat Through Plates from Hot Gases to Water. George Halliday. A paper read at the Sheffield, Eng., meeting of the Institution of Eng. and Shipbuilders in Scotland. Presents the leading known facts on this question. 2500 w. Ind & Ir—June 24, 1898. Serial. [1st part. No. 21320 A.

High Pressure Steam.

See Mining and Metallurgy—Mining.

Petroleum.

Petroleum Vapor; Its Production and Use. J. S. V. Bickford. Results of experience in the fields of petroleum Bunsen burner, and petroleum blow-pipe work. Ill. 4200 w. Eng, Lond—July 15, 1898. No. 21628 A.

Riveting.

Causes of Certain Steam Boiler Explosions. (Causes d'Explosion de Certaines Chaudières.) A review of M. Fremont's paper upon the injury to the metal which is caused by careless treatment in riveting. Serial. 1st part. 2500 w. Le Génie Civil—July, 9, 1898. No. 21717 D.

Smoke.

A Method of Estimating Smoke. (Méthode d'Estimation des Fumées.) Max Ringelmann. A description by Prof. Ringelmann of his smoke scale for classifying the degrees of smokiness of a factory chimney; showing how the scale is constructed and used. 2000 w. La Revue Technique—June 25, 1898. No. 21702 D.

The Hinstin Smokeless Furnace. (Les Foyers Fumivores de M. J. Hinstin.) Describing and illustrating the Hinstin furnace as applied to steam boilers, and accepted by the municipal authorities for use within the city limits of Paris. 1200 w. La Revue Technique—July 10, 1898. No. 21708 D.

Water Columns.

Water Column Connections. H. H. Kelly.

Calls attention to some elements of danger arising from the neglect of water columns, or of wrong connections. Ill. 1400 w. *Sci Mach*—July 1, 1898. No. 21365.

Water-Tubes.

The Problem of Combustion in Water-Tube Boilers, and a Means of Its Solution. James Weir. Paper read at meeting of Inst. of Engs. and Shipbuilders in Scotland. Analyzes the phenomena of combustion, showing why it is defective and giving a solution. An important paper. Discussion. Ill. 5500 w. *Steamship*—July, 1898. No. 21448 A.

COMPRESSED AIR.

Air Receivers.

Constant Pressure Air Receivers. E. A. Rix. Describes a way to overcome the volumetric loss. It consists in having a pipe connected at the lowest point of the receiver, and with a water tank high enough to give constant pressure. 1200 w. *Am Mach*—July 7, 1898. No. 21360.

Compressor.

A Simple Air Compressor. C. P. Turner. Illustrated description of the hydraulic air compressor. 1400 w. *Min & Sci Pr*—June 25, 1898. No. 21264.

Liquefied Air.

Liquefied Air for Industrial Purposes. From *La Nature*. Illustrated description of Dr. Linde's apparatus which produces about 28 ounces of liquefied air per hour with an expenditure of 3 h. p. to actuate the pumps. 1000 w. *Sci Am Sup*—July 2, 1898. No. 21261.

Liquefied Air. George F. Barker. Considers the processes for liquefying air, its appearance, means of transportation, effect on other substances, applications, &c. 2500 w. *Chau*—Aug., 1898. No. 21663 c.

Water Blast.

On a New Form of Water Blast. Bertram B. Boltwood. Describes and illustrates the essential parts of the apparatus and its action, stating the advantages and giving result of tests to determine the efficiency. 1000 w. *Am Chem Jour*—July, 1898. No. 21497 D.

ENGINES AND MOTORS.

Agricultural Motors.

International Competition of Agricultural Motors. (Concours International des Moteurs Agricoles.) Camille Lambotte. An illustrated review of the steam and petroleum motors for agricultural service as shown at the Brussels exhibition in 1897. 3000 w. *Revue Universelle des Mines*—June, 1898. No. 21718 H.

Air Pumps.

Independent Air Pumps of Marine Engines. A. B. Willets. Presents the many advantages, and the methods of working, &c. Ill. 1600 w. *Ir Age*—June 30, 1898. No. 21242.

Compound Engines.

Non-Condensing Compound Engines for Office Buildings. William H. Bryan. A letter advocating their use in place of simple engines. 1000 w. *Eng Rec*—July 2, 1898. No. 21311.

Non-Condensing Compound Engines for

Office Buildings. Letters from Charles G. Darrach and Phoenix Iron Works Co., comparing the advantages of condensing and non-condensing engines for such service. 1200 w. *Eng Rec*—July 9, 1898. No. 21422.

Compression.

The Compression of Steam in the Clearance Space. (La Compression de la Vapeur dans l'Espace Mort.) J. Boulvin. A critical review of the experiments of Prof. Dwelshauvers Dery, showing that the losses charged to compression of the exhaust steam are those inevitably due to the action of the cylinder walls. The entropy diagram is applied in an instructive manner. 7000 w. *Revue de Mécanique*—June, 1898. No. 21728 H.

Gas Engines.

Small Gas Engine Cylinders. Herbert L. Towle. Discusses the influence of cylinder diameter on efficiency, showing the low economy of small cylinders and the advantages of multi-cylinder arrangement. 1500 w. *Am Mach*—July 28, 1898. No. 21678.

Indicator.

A New Continuous Recording or Integrating Engine Indicator. Illustrates and describes an instrument invented by W. G. and C. W. G. Little, of Bexley, Kent, England, and explains its operation and theory. 1700 w. *Eng News*—July 28, 1898. No. 21696.

Lubrication.

The Lubricating of Engine Cylinders. Considers the principal causes of cutting and grooving. 1400 w. *Bos Jour of Com*—July 23, 1898. No. 21604.

Oil Engines.

Oil Engines. Capitaine v. Diesel. Discussion of a paper by E. Capitaine criticizing the theory propounded by Herr Diesel and the results he has obtained. 4000 w. *Engr, Lond*—July 8, 1898. No. 21554 A.

Steam Engine.

The Criticisms of the Steam Engine. (Ueber die Beurteilung der Dampfmaschine.) Richard Mollier. A discussion of the theoretical thermal and mechanical efficiencies of the steam engine, in comparison with results obtained by actual test. A large comparative table is given. 4500 w. *Zeitschr d Ver Deutscher Ing*—June 18, 1898. No. 21732 D.

Testing.

Four Days' Tests on a Sulzer Triple Steam Pumping Engine. Summary by Bryan Donkin, of an interesting set of tests made by Prof. Stodola, of Zurich. 500 w. *Engr, Lond*—July 1, 1898. No. 21469 A.

Traction Engines.

Something About Traction Engines. Joseph B. Hall. On their principal uses and the treatment they receive. Ill. 1000 w. *Am Mach*—July 21, 1898. No. 21580.

Valves.

Friction of Throttle Valves. An editorial pointing out the wire-drawing resulting from valves of bad form. 500 w. *Eng Rec*—July 23, 1898. No. 21610.

POWER AND TRANSMISSION.**Elevator.**

The Reno Inclined Elevator in a Department Store. Illustrates and describes the installation of this elevator in the department store of Bloomingdale Bros., New York. 1200 w. Elec Eng, N. Y.—July 7, 1898. No. 21427.

Gas Power.

Gas Power. J. Barton. Read before the Federated Inst. of Min. Engs., England. Giving some practical results of working engines with generator gas. 2500 w. Pro Age—July 1, 1898. No. 21275.

The Operating Cost of Gas Power Plants. (Die Betriebskosten von Gasmotorenanlagen.) J. Körting. A discussion of the operative cost of gas engines as compared with steam including all fixed charges, and considering various kinds of gas. 3500 w. Zeitschr d Ver Deutscher Ing—June 18, 1898. No. 21735 D.

The Utilization of Blast Furnace Gas as Motive Power. (De l'Emploi des Gaz de Hauts Fourneaux comme moteurs.) An account of the experiments at Seraing, Belgium, with illustration of the 200 h. p. gas engine operated by furnace gases. 3000 w. La Revue Technique—July 10, 1898. No. 21706 D.

Hoisting Machines.

The Brown Hoisting and Conveying Machines. Axel Sahlin. Paper read before a special meeting of the Düsseldorf branch of the Verein Deutsche Eisenhüttenleute. Introductory remarks on the conditions that have enabled the United States to compete with Europe in the iron and steel industry, followed by illustrated description of the Brown machines. 5800 w. Engng—July 8, 1898. No. 21542 A.

Hydraulic Plant.

See Electrical Engineering, Power.

Piping.

Neglected Considerations in the Arrangement of Steam Piping. W. Cooper. A careful discussion of the correct proportions of steam piping, showing the causes for loss, and the best methods of meeting them. 3500 w. Engineering Magazine—August, 1898. No. 21793 B.

Transmission.

A Topical Discussion Upon Electrical, Pneumatic and Mechanical Power Transmission in Manufacturing Establishments. Ill. 12000 w. Jour W Soc of Engs—June, 1898. No. 21436 D.

Transportation.

Overhead Tramways. Henry Wysham Lannier. An interesting illustrated account of the wire ropeway construction for getting into the gold regions of the Yukon basin. 2500 w. Chau—Aug., 1898. No. 21664 C.

Water Wheels.

A Complete Theory of Impulse Water Wheels and Its Application to Their Design. R. T. Kingsford. Mathematical demonstration. 2500 w. Eng News—July 21, 1898. No. 21595.

SHOP AND FOUNDRY.**Ball Bearings.**

A Theoretical Study of Ball Bearings. (Etude

Theorique sur les Roulements à Billes.) C. Bourlet. A valuable discussion, with many diagrams, showing the mechanical action of the various forms in use with their advantages and disadvantages. Two articles. 6000 w. Le Génie Civil—July 2, 9, 1898. No. 21715, each D.

Belt Holes.

Plotting Belt Holes in Floors and Partitions by Proportion. M. H. Avery. Letter to editor, with illustration, explaining method used by writer. 500 w. Am Mach—June, 1898. No. 21248.

Brass.

Melting, Mixing, and Casting Brass. John A. Macauley. Considers only mixtures in everyday use which are of practical value. 1600 w. Foundry—July, 1898. No. 21478.

Casting.

Centrifugal Casting. (Ueber Zentrifugalguß.) Ernst Lewicki. Describing the centrifugal method of obtaining sound castings. The mould is revolved rapidly, forcing the melted metal to the circumference. 3500 w. Zeitschr d Ver Deutscher Ing—June, 25, 1898. No. 21737 D.

Making a Large Standardizing Casting. Thomas D. West. Read before the Pittsburg Foundrymen's Assn. Gives plan for obtaining 300 pounds or more of absolutely clean and uniform drillings for standardizing purposes. Ill. 1200 w. Ir Trd Rev—June 30, 1898. No. 21271.

Cast Iron.

On the Molecular Changes in Cast Iron Caused by Vibration. Report of the Franklin Institute, through its Committee on Science and the Arts, on the investigations of A. E. Outerbridge, Jr. 700 w. Jour Fr Inst—July, 1898. No. 21304 D.

Cone Pulleys.

A New Cone Pulley Diagram. From a pamphlet by Walter H. Palmer. Diagram for open belts with description of its application. 1100 w. Am Mach—July 14, 1898. No. 21472.

Dividing Device.

The Mundo Wheel Dividing Device. Morris Fulton. Illustration with description and mode of operation. 2000 w. Am Mach—July 21, 1898. No. 21581.

Furnace.

The Baumann Tilting Pre-Heating Crucible Furnace. (Baumann's Aufkippbar Vorwärmar-Tiegelofen.) An ingenious form of crucible furnace in which the charge is heated by the escaping gases before entering the crucible. 1200 w. Stahl und Eisen—June 15, 1898. No. 21745 D.

Gear Teeth.

Dimensions of Gear Teeth in the Metric System. Peder Lobben. Explains the application of the metric system to gear calculations. 350 w. Am Mach—June 30, 1898. No. 21245.

Table of Strength of Cut Gear Teeth. Henry Hess. A table prepared to allow the pitch and

the face to be found with very little arithmetic. It is based on Lewis' method of calculating the strength of gear teeth. 800 w. Am Mach—July 7, 1898. No. 21359.

Geneva Stop.

Three Modifications of the Geneva Stop. Illustrated description of three modifications of the device used in watches to prevent over-winding which have been recently applied by Hugo Bilgram to various automatic machines. 1500 w. Am Mach—June 30, 1898. No. 21246.

Index Plate.

Making an Accurate Index Plate. G. P. Wetmore. Illustrates and describes the manner of doing the work. 1000 w. Am Mach—July 7, 1898. No. 21356.

Lathes.

Some Tools Used in Lathe Building. W. L. Shellenback. Illustrated description of devices and manner of using them. 500 w. Am Mach—July 7, 1898. No. 21358.

Lathe Testing.

Tools for Lathe Testing. Oscar E. Perrigo. An illustrated account of a simple and not expensive apparatus for this purpose. 1000 w. Am Mach—July 21, 1898. No. 21582.

Metal Work.

Cast Metal Work from Benin. Illustrates and describes the pieces showing high artistic excellence, brought from West Africa. 1600 w. Nature—July 1898. No. 21522 A.

Molding.

Stripping Plate Molding Machines. E. H. Mumford. Read before the New England Foundrymen's Assn. Discusses some of the problems arising with machines for general work, quoting from a letter from John C. Mellon, giving his experience with stripping plate patterns in constant use. 2200 w. Ir Trd Rev—June 30, 1898. No. 21272.

Rivets.

The Shearing Resistance of Steel Rivets. An editorial review of the basis of current practice. 800 w. Eng Rec—July 2, 1898. No. 21305.

Shop Costs.

Effective Methods of Finding and Keeping Shop Costs. Henry Roland. A description of the system used by the Hyatt Roller Bearing Company, with copies of blank forms, books, &c., and all working details. 4000 w. Engineering Magazine—August, 1898. No. 21794 B.

Studs.

Some Practical Hints on the Making of Studs. F. F. Hemenway. Illustrates and describes a method used by the writer. 1200 w. Prac Eng—July 1, 1898. No. 21450 A.

Tapping.

A Tapping Tool. A. H. Cleaves. Illustrates and describes a convenient tool. 400 w. Am Mach—July 14, 1898. No. 21471.

MISCELLANY.

Areas.

The Truth and Errors of Mr. Wiener's

Method of Finding the Area of Curvilinear Figures. J. J. Guest. A demonstration of the method in proof of its truth. 800 w. Am Mach—July 7, 1898. No. 21357.

Wiener's Method of Graphic Integration. Leicester Allen. Highly commending the method, and giving some points in its application. Ill. 1500 w. Am Mach—July 28, 1898. No. 21677.

Automobiles.

Competition of Automobile Hackney Carriages. Illustrates some of the vehicles that took part in the competition in France. 400 w. Sci Am Sup—July 2, 1898. No. 21258.

The Automobile Cab Competition. (Le Concours de Fiages Automobiles.) C. Bontain. A detailed account of the prize competitions of the Automobile Club of Paris, with photographs of the vehicles, and a map of the routes. 3 00 w. 1 plate. La Revue Technique—June 25, 1898. No. 21704 D.

The Automobile Exhibition of the Tuileries. (L'Exposition d'Automobiles des Tuileries.) The first of a series of articles illustrating and describing the vehicles exhibited at the exposition held by the Automobile Club, after the cab competition in Paris. Serial. 1st part. 1200 w. La Revue Technique—July 10, 1898. No. 21710 D.

The Competition for Automobile Cabs. (Concours pour Voitures de Place Automobiles.) A general account of the Automobile Club competition, with a review of the performance of the various competing vehicles. 2500 w. Le Génie Civil—June 25, 1898. No. 21713 D.

The Patin Electrical Motor Carriage. Illustrated description of a carriage designed by M. O. Patin, possessing several novel features. 800 w. Ind & Ir—June 24, 1898. No. 21321 A.

The Paris Motor-Cab Competition. An account of the trials promoted by the French Automobile Club, with illustrated descriptions of the vehicles entered. 4300 w. Automotor Jour—July, 1898. No. 21665 A.

The Weidknecht and Bourdon Steam Omnibus. Illustrated description of this vehicle. 600 w. Automotor Jour—July, 1898. No. 21666 A.

Bicycles.

Bicycle Efficiency Tests. A. H. Eldredge and G. B. Preston. A description of the method of testing, with a comparison of the efficiency of different types of bicycles under various conditions, and the relative efficiency of solid, cushion and pneumatic tires. Ill. 4000 w. Mach, N. Y.—July, 1898. No. 21244.

Elasticity.

The Law of Elasticity and its Practical Application. (Das Elastizitätsgesetz und seine Anwendung für Praktische Rechnung.) Rudolph Bredt. A mathematical discussion of the relation between stress and strain with examples of application to practical computation. 4000 w. Zeitschr d Ver Deutscher Ing—June 18, 1898. No. 21734 D.

Liquid Air.

Liquid Air. (L'Air Liquide.) A communication to the French Academy by M. d'Arson-

val, relating the results of his experiments with the Linde apparatus. 2500 w. *Comptes Rendus*—June 13, 1898. No. 21722 D.

Lubrication.

Lubrication from an Engineer's Point of View. William M. Davis. Reviews some of the laws relating to friction, and discusses the value of oils used, and the conditions affecting lubrication. 1500 w. *Sci Mach*—July 1, 1898. No. 21366.

Sampling and Testing Lubricating Oils and Fats in the Workshop. Instructions for ascertaining whether a lubricating oil or fat is pure or not, and, if not, what is the nature of the adulterating body. 2000 w. *Engr, Lond*—July 15, 1898. Serial. 1st part. No. 21629 A.

Oxygen.

The Industrial Preparation of Oxygen. (*Préparation Industrielle de l'Oxygene.*) P. Crépy. A description of the Garuti process of making oxygen on a commercial scale by the electrical decomposition of water. 1000 w. *La Revue Technique*—July 10, 1898. No. 21707 D.

Pipe Coverings.

The Selection of Steam Pipe Coverings. Editorial on fallacy of judging the efficiency of

coverings by tests of short duration. 800 w. *Eng Rec*—July 2, 1898. No. 21306.

Testing Machine.

The Laboratory Testing Machine at University College, Cardiff. Extracts from a lecture delivered to the Inst. of Junior Engs., England, by A. C. Elliott. Illustrated detailed description of the machine and its operation. 4400 w. *Engng*—July 1, 1898. No. 21463 A.

Testing.

Testing Material for Rolling Stock. George T. Glover. An account of the present requirements for railway rolling-stock material in England, and the manner in which the tests are carried out. 2000 w. *Engr, Lond*—July 1, 1898. Serial. 1st part. No. 21467 A.

The Accuracy of Testing Machines and the Results of Rupture Tests. (*Ueber die Genauigkeit der Festigkeitsmaschinen und der Ergebnisse von Zerreißversuchen.*) Prof. B. Kirsch. A comparison of tests made upon identical specimens of various machines, showing the probable error due to the apparatus. 3000 w. *Stahl und Eisen*—June 15, 1898. No. 21746 D.

Tests.

On Comparative Tests. W. H. Booth. On the unreliability of such tests. 1500 w. *Am Mach*—July 28, 1898. No. 21675.

MILITARY ENGINEERING.

Ambulance Service.

The Red Cross Society and the Ambulance Service. Short account of the society with illustrated description of the ambulance service. 1200 w. *Sci Am*—July 23, 1898. No. 21585.

Battleship.

H. M. S. Albion. Describes the vessel and her armament, calling attention to interesting features in the design. 2200 w. *Engng*—June 24, 1898. No. 21226 A.

H. M. S. Amphitrite. Illustration with description of ship and armament. 900 w. *Engr, Lond*—July 15, 1898. No. 21630 A.

The Demand for Faster Battleships. Editorial urging the importance of speed, and commenting on the lessons to be learned from the recent destruction of the Spanish fleet. 2500 w. *Eng News*—July 21, 1898. No. 21596.

The Spanish Battleship "Pelayo." Describes and illustrates this formidable vessel of the Spanish navy, and its armament. 2800 w. *Sci Am Sup*—July 16, 1898. No. 21476.

The Vitals of a Battleship. Richard Lee Fearn. Description of the battleship Iowa. Ill. 2200 w. *Chau*—Aug., 1898. No. 21662 C.

Bullets.

The Causes of the Explosive Effect of Modern Small Calibre Bullets. Charles E. Woodruff. Part first explains the vibrations of wave motions and their effects, and attributes the explosive effect to the capability or incapability of the tissues to transmit these wave motions. 3800 w. *Sci Am Sup*—July 2, 1898. No. 21263.

Commerce-Destroyers.

Confederate Commerce-Destroyers. I. The

Tallahassee's Dash into New York Waters. John Taylor Wood. An account of the cruise of this vessel by her commander. II. The Eventful Cruise of the Florida. G. Terry Sinclair. A former midshipman's account. Ill. 12200 w. *Century Mag*—July, 1898. No. 21257 D.

Cruiser.

Fourth-Class Cruiser "G" of the German Navy. From *Illustrirte Zeitung*. Brief description with illustration of a vessel being constructed at Krupp's Germania Dock, at Kiel. 400 w. *Sci Am Sup*—July 30, 1898. No. 21682.

H. M. Cruiser "Highflyer." Illustrated description of a second-class cruiser, recently launched. 1800 w. *Engs' Gaz*—July, 1898. No. 21449 A.

The Argentine Cruiser "General San Martin." Illustrated description of vessel and equipment, with report of trials. 1800 w. *Engng*—July 15, 1898. No. 21634 A.

The Machinery of the Dutch Cruiser "Friesland." The particular feature is the use of water-tube steam generators in combination with boilers of the ordinary cylindrical type. Ill. 700 w. *Engng*—July 1, 1898. No. 21464 A.

The Reconstructed Cruiser "Newark." Describes the vessel as first constructed and the alterations made. Ill. 1300 w. *Sci Am*—July 23, 1898. No. 21584.

The United States Armored Cruiser "Brooklyn." Illustrated description of this vessel and her armament, with report of official speed trial. 2800 w. *Sci Am*—July 16, 1898. No. 21474.

Guns.

Concerning Our New Cannon. (A Propos Notre Nouveau Canon.) Leo Dex. A discussion of the present French field piece in comparison with guns of the Maxim-Nordenfellt type. 1500 w. *La Revue Technique*—June 25, 1898. No. 21701 D.

The Krupp 7.5 Cm. Rapid Fire Gun in the Cuban Campaign. Atanasio Torres. Reviews the causes that led to the adoption of this gun in the Spanish army, the difficulties which interfered with the proper equipment of the batteries, and a discussion of its use in the Cuban campaign. 6500 w. *Jour of U S Artillery*—May, June, 1898. No. 21442 D.

The Sims-Dudley Powder Pneumatic Gun. Illustrated description of a gun, known as a dynamite gun, though really charged with Nobel's gelatine. 1000 w. *Am Mach*—July 28, 1898. No. 21676.

Working a Big Gun. Brief account of how the 13-inch destroyer is operated in a battle. 600 w. *Bos Jour of Com*—July 2, 1898. No. 21312.

Military Bridges.

Military Bridges. Illustrated extracts from U. S. War Dept. manuals. 2000 w. *Eng Rec*—July 16, 1898. No. 21504.

Military Power.

The Fighting Strength of the United States. F. W. Hewes. A comparison of the resources of the several nations. Ill. 2500 w. *McClure's Mag*—July, 1898. No. 21270.

Military Roads.

Road Manual for the U. S. Armies of Invasion. Reprint of instructions for use of the forces invading Spanish colonies, prepared by Gen. Roy Stone of Gen. Miles' staff. 1400 w. *Eng Rec*—July 2, 1898. No. 21310.

Naval Programme.

The Navies and Naval Construction Programme of 1898. H. W. Wilson. A review of the present tendencies in naval design, armament, and engineering, with especial reference to the new construction work of the present year. 3500 w. *Engineering Magazine*—August, 1898. No. 21790 B.

Spanish Fleet.

The Remains of Cervera's Fleet. Illustrated description of the vessels showing the effect of the recent battle. 1400 w. *Sci Am*—July 30, 1898. No. 21679.

Targets.

Moving Targets in Use in the Light Artillery of England, Germany, France, Italy, and Some Forms Recently Tried by the Light Artillery Battalion at Fort Riley, Kansas. C. G. Treat. Illustrated description of moving targets for gunner's practice. 3400 w. *Jour of U S Artillery*—May-June, 1898. No. 21441 D.

Torpedoes.

The Whitehead Torpedo. W. J. Sears. From the Pro. of the U. S. Naval Inst. Illustrated description, with a brief summary of its preparation for a run. 6000 w. *Engng*—July 15, 1898. No. 21639 A.

MINING AND METALLURGY.**COAL AND COKE.****Anthracite.**

Anthracite in the Rockies. R. M. Hosea. The causes which produced it and the methods used in mining and preparing it. A geographical and geological description of the region in which it is found and some of the peculiar difficulties met with in exploiting the properties. Ill. 4800 w. *Mines & Minerals*—July, 1898. Serial. 1st part. No. 21404 C.

Charcoal Kiln.

The Ljungberg Continuous Charcoal Kiln. E. J. Ljungberg. States the principles to be observed, and describes the continuous kiln and its operation. 3500 w. *Ir Age*—July 28, 1898. No. 21669.

Coal Preparation.

Coal Preparation and Washing Plant at a Westphalian Colliery. E. Tomson. From a communication to the jubilee meeting of the Liège Engs'. Assn. Illustrates and describes a double picking and screening plant, and a washing plant for the nuts and slack, capable of dealing with 100 tons per hour. 1500 w. *Col Guard*—July 1, 1898. No. 21454 A.

Coal Supplies.

The Coal Supplies of the World. Benjamin Taylor. An interesting review of the production, importance and consumption of this

mineral in all parts of the world, with special statistics of the English supply. 7300 w. *Nineteenth Cent*—July, 1898. No. 21778 D.

Coking.

On Coking in By-Product Ovens. John H. Darby. Read before the Iron and Steel Inst. Data showing that well-made retort coke is economical in the blast-furnace, and that some fuels that will not coke satisfactorily in the beehive ovens, will produce a marketable coke in the retort oven. 2500 w. *Engng*—July 1, 1898. No. 21466 A.

Deposits.

Coal Find and Mining Operations Between Boulogne and Calais. Abstract of report of M. Olry. Favorable to the sinking of a shaft in this district giving information of the deposit. 2300 w. *Col Guard*—July 1, 1898. No. 21457 A.

Explosives.

The Testing of Explosives for Use in Coal Mines. A report by A. Cooper-Key, inspector of explosives at the Home Office Testing Station, Woolwich, England. 3500 w. *Col Guard*—July 8, 1898. No. 21550 A.

Haulage.

Förster and Dinnendahl Arrangements for Rope Haulage. Leon Navez. From a communication to the Société des Ingénieurs des

Mines du Hainaut. Illustrates and describes two systems much used in Germany, which give excellent results. 1200 w. Col Guard—June 24, 1898. No. 21330 A.

Mining Haulage. G. W. Westgarth. Abstract of paper read before the British Society of Mining students. Considers the systems of rope haulage and their cost. 1800 w. Ir & Coal Trds Rev—July 8, 1898. No. 21547 A.

Hydrometers.

Experiments on Hydrometers and Anemometers. Prof. Rateau. From *Annales des Mines*. Experiments with these measuring instruments to determine the degree of approximation obtainable in the various circumstances, and the causes which diminish that approximation. 3000 w. Col Guard—July 8, 1898. Serial. 1st part. No. 21548 A.

Nova Scotia.

A Nova Scotia Coal Mine. An illustrated account of the mines of the Cumberland Railway and Coal Company. 5000 w. Ir & Coal Trds Rev—July 8, 1898. No. 21546 A.

Production.

Coal Production, Consumption and Value. Editorial on the report of the British Board of Trade regarding the fuel supply of the world. 1300 w. Engng—June 24, 1898. No. 21325 A.

Russia.

Coal and Iron in Russia. From a Consular Report. Reports concerning these industries, giving production. 1500 w. Col Guard—July 1, 1898. No. 21458 A.

South Africa.

The Coal Fields of South Africa. Reports concerning the increased activity and competition in this district, mentioning individual collieries. 1000 w. Col Guard—July 8, 1898. Serial. 1st part. No. 21553 A.

COPPER.

By-Products.

The Relation of By-Products to Cost of Copper Production. Discusses the margin of profit between cost of production and selling value. Gives information of the Anaconda, the Boston & Montana, and the Rio Tinto. 1200 w. Eng & Min Jour—July 9, 1898. No. 21432.

Copper Deposits.

The Origin and Mode of Occurrence of the Lake Superior Copper Deposits. M. E. Wadsworth. A general idea of the geology of this region and the writer's explanation of the facts observed. 13000 w. Trans Am Inst of Min Eng—July, 1897. No. 21620 D.

Mines.

The Stora Kopparberg's Great Copper Mines at Falun. Illustrated detailed description of one of the oldest mines in the world. 3000 w. Ir & Coal Trds Rev—July 15, 1898. No. 21350 A.

Refining.

Progress in Electrolytic Copper Refining During 1897. Titus Ulke. From "The Mineral Industry," Vol. VI. Brief review of improvements in mechanical details and chemical

methods, describing various modes of treatment. 4500 w. Eng & Min Jour—July 2, 1898. No. 21355.

Tamarack Mine.

Some Notes on a Lake Superior Copper Mine. Photographs of underground workings of the Tamarack mine in Michigan, with notes. 700 w. Eng & Min Jour—July 9, 1898. No. 21433.

GOLD AND SILVER.

Beating.

Gold Beating. O. G. Holt. An interesting description of the process which is practiced very much as it was three thousand years ago. 1800 w. Sci Am—July 30, 1898. No. 21680.

Cyanid.

Notes on the Application of Oxygen in the Cyanid Process. H. T. Durant. Considers the use of atmospheric or molecular oxygen, and the methods of application, giving the results of experiments made. Ill. 1800 w. Jour of Chem & Met Soc of S. Africa—May, 1898. No. 21655 E.

The Cyanid Process. J. Stanley Muir. Discusses the means of ascertaining what ores are amenable to this treatment, the necessity of expert examination in order to get the most profitable results, with description of the process. 2000 w. Min Rept—July 7, 1898. No. 21559.

The Cyanid Process. Louis Fade. Read before the International Mining Congress at Salt Lake City. Discusses the preliminary treatment of the ore, crushing, sorting, &c., the Elsner theory, and the success of the process. 2800 w. Min & Sci Pr—July 16, 1898. No. 21592.

Utah's Latest Triumph. An illustrated detailed description of the great De La Mar cyanid plant at Mercur, and its operation. 3000 w. Min Rept—July 21, 1898. No. 21640.

Dredging.

Dredging in New South Wales. An interview with Mr. C. L. Garland regarding the progress made in dredging for gold, which gives promise of satisfactory results. 2000 w. Aust Min Stand—June 9, 1898. No. 21576 B.

Georgia.

Gold Mining in Georgia. William Tatham. An account of the mines and mining and the opportunities for those possessing capital and experience. 2800 w. Jour Fr Inst—July, 1898. No. 21299 D.

Gold Milling.

Gold Milling in Colorado. John Roger. The first of a series of articles proposing to give an accurate description of three gold mills recently erected in Colorado, dealing with the subject more especially from a mechanical point of view. Ill. 2200 w. Engng—July 1, 1898. Serial. 1st part. No. 21462 A.

Gold Mining.

The History of Gold Mining. M. C. Ihlseng. An extract from an illustrated lecture delivered before the Engineers' Club, of Scranton, Pa. 2500 w. Mines & Min—July, 1898. No. 21406 C.

Gold Recovery.

Recovery of Gold from Low Grade Ores. Describes a new process recently tried with great success in California. 900 w. *Sci Am*—July 23, 1898. No. 21586.

Guiana.

The Gold Fields of Guiana. H. Tweddle. Historical sketch with illustrations. 6000 w. *Eng & Min Jour*—July 23, 1898. No. 21609.

India.

The Gold Resources of India. William King and Theodore Wm. Hughes Hughes. An exhaustive review of the gold regions of India, with especial regard to the Mysore District. 5000 w. *Engineering Magazine*—August, 1898. No. 21798 B.

Lodes.

Australian Lodes and Fissures. William Davey. The writer having had large experience in mining, gives some opinions relating to the conditions under which gold may be reasonably expected. Ill. 3500 w. *Aust Min Stand*—May 19 & 26, 1898. Serial. 2 parts. No. 21335 each B.

Theories of the Formation of Lode Matter. F. Sandberger. Translated from the German. Discusses the ascension and lateral secretion theories from a chemical, geological standpoint. 6500 w. *Aust Min Stand*—May 26, and June 2, 1898. Serial. 2 parts. No. 21337 each B.

Peculiar Mine.

A Peculiar Ore Body. Arthur Lakes. Describes a peculiar mine near Cripple Creek and how the method of working resulted in a serious accident. 1200 w. *Mines & Min*—July, 1898. No. 21410 C.

Precipitation.

Statement as to My Process of Precipitating Gold by Means of Copper Salts. P. de Wilde. Replies to the objections, from various quarters, to the writer's process for precipitating gold from solutions of cyanid by means of sulphurous acid and sulphate of copper. 1700 w. *Jour of Chem & Met Soc of S. Africa*—May, 1898. No. 21657 E.

Prospecting.

A Guide for Prospectors. W. C. Wynkoop. The first of a series of articles intended to aid prospectors, and giving such information as will enable one to recognize valuable ores when discovered. 2000 w. *Min Repts*—July 7, 1898. Serial. 1st part. No. 21560.

Saddle Reefs.

Saddle Reefs at Hargraves, New South Wales. J. Alex. Watt. Description of these reefs with illustrations. 2800 w. *Aust Min Stand*—June 9, 1898. No. 21577 B.

Silver-Lead.

Mount Deddick Silver-Lead Field. Full text of the government geologist's report on this Australian field, with sketch plans. 2000 w. *Aust Min Stand*—May 26, 1898. No. 21336 B.

Sulphurets.

Experimenting with and Processes by Which Sulphurets from the Plymouth Rock, Cal., Mine

are worked. T. K. Code. Gives details of the experiments and results. The process by which the ores are now worked. Costs \$6.50 per ton. 900 w. *Min & Sci Pr*—June 25, 1898. No. 21265.

Tailings.

The Treatment of Tailings in the Witwatersrand. E. P. Chester. Illustrated description of the process in use. 1100 w. *Eng & Min Jour*—July 2, 1898. No. 21354.

Tellurium.

Tellurium and the Telluride Ores of Cripple Creek, Colorado, as illustrated by specimens in the State Mining Bureau, Denver. Arthur Lakes. Information concerning these ores, their appearance and detection. 3800 w. *Mines & Min*—July, 1898. No. 21405 C.

Victoria.

Gaffney's Creeek (Vic.). Gives views and details of some of the principal mines of this district. 2000 w. *Aust Min Stand*—June 2, 1898. No. 21338 B.

Vulcan Mine.

Ores of the Vulcan Mine. Arthur Lakes. A strange mine in Colorado with remarkable formations and a peculiar gold-bearing rock. 2000 w. *Mines & Min*—July, 1898. No. 21411 C.

IRON AND STEEL.**Bessemer Process.**

The Thermo-Chemistry of the Bessemer Process. Noel Hartley. Gives an outline of the process and its modifications, and an account of the phenomena observed while the process is in operation. Illustrates and describes various converters. 7000 w. *Jour Soc of Arts*—July 8, 1898. Serial. 3 parts. No. 21520 each A.

Blast Furnaces.

Management of Blast Furnaces. E. S. Cook. Lecture delivered to third year students in metallurgy in the Schools of Mines and Chemistry, Columbia University, New York. Relates the writer's experience, discussing fluxing, fuel, and ores. 2500 w. *Ir Trd Rev*—July 21, 1898. Serial. 1st part. No. 21591.

Cast Iron.

See Mechanical Engineering, Shop & Foundry.

Iron Ore.

British Iron Ore Requirements and Sources of Supply. Part first describes the position of the United Kingdom, and countries of Europe in regard to the supply. 3000 w. *Col Guard*—July 8, 1898. Serial. 1st part. No. 21549 A.

The Oolitic Formation of German Lorraine. (Die Minettenformation Deutsch-Lothringens.) Dr. W. Kohlmann. A general account of the geology of the region, with fine geological map, sections and borings. 7500 w. 3 plates. *Stahl und Eisen*—July 1, 1898. No. 21747 D.

Japan.

The Basis of the Japanese Iron Industry. (Die Grundlagen der Japanischen Eisenindustrie.) A review of the iron and manganese ore supplies of Japan, together with the fire clays and other materials. 1000 w. *Stahl und Eisen*—June 15, 1898. No. 21744 D.

The Raw Materials of the Japanese Iron Industry. Translated from *Stahl und Eisen*. Information of the iron ore deposits, the manganese ores, and refractory materials. 600 w. *Ir & Coal Trds Rev*—June 24, 1898. No. 21332 A.

Rolling.

Difficulties in Rolling. William Hirst. Discusses some of the difficulties common to the roller's art, pointing out faults or errors that are the usual cause of trouble. Ill. 3700 w. *Ir Age*—June 30, 1898. No. 21241.

Rolling Mills.

Electric Power in Rolling Mills. Eugene B. Clark. From a topical discussion conducted by the Western Society of Engineers. Mentions some of the uses to which the power is applied, and the results. 1600 w. *Ir Age*—July 21, 1898. No. 21590.

Steel Plant.

The New Open Hearth Plant of the Carnegie Steel Company, Limited. Illustrated description of the main features of this fine plant. 2200 w. *Ir Age*—June 30, 1898. No. 21243.

The Steel and Iron Works of Trignac. (Les Aciéries, Haut Fourneaux et Forges de Trignac.) Hubert Bya. A full description of these important works, near St. Nazaire, France, with plates of details. 9000 w. 4 plates. *Revue Universelle des Mines*—June, 1898. No. 21720 H.

Urals.

The Iron Industry of the Urals. G. Kamensky. Reviews the history of this industry, its immense resources, the treatment required for the ores, &c. 3000 w. *Col Guard*—July 1, 1898. No. 21459 A.

Works.

Our Iron and Steel Works in 1898. James M. Swank. Extracts from preface to the Fourteenth Edition of the Directory to the Iron and Steel Works of the United States, published by the American Iron & Steel Assn. 1800 w. *K R Gaz*—July 8, 1898. No. 21397.

MINING.

Deep Mines.

Hoisting Plant for Deep Mines. (Forderungen für Grosse Tiefen.) E. Tomson. A very full account of the plant at the Preussen mine at Dortmund, with detail drawings, computations and much valuable information. Four articles. 12000 w. 20 plates. *Glückauf*—June 4, 11, 18, 25, 1898. No. 21750 each B.

Steam Raising, Motive Power, and Accessory Winding Engines at a Westphalian Colliery. E. Tomson. From a communication to the jubilee meeting of the Liège Engs' Assn. Describes an installation of the Preussen Colliery, No. 1 pit. Ill. 2000 w. *Col Guard*—July 8, 1898. No. 21551 A.

Electric Pump.

Underground Electric Pump at the Anzin Colliery. M. Barry, and M. Baudot. From a communication to the Société de l'Industrie Minérale. Illustrated description of a pump installed at the Lambrecht pit of the Anzin Colliery. The distinguishing features are the use

of the continuous current with a tension of 500 volts, and of a dynamo and motor with moderate speed. 3500 w. *Col Guard*—July 15, 1898. No. 21631 A.

High-Pressure Steam.

The Use of High-Pressure Steam at Collieries. Hugh Bramwell. From the Jour. of the British Soc. of Min. Students. Notes, recording experience gained as to the care necessary in adopting a high boiler pressure at collieries. 1600 w. *Col Guard*—July 1, 1898. No. 21455 A.

Instruments.

The Pantograph and Planimeter. Charles E. Bowron. A description of some of the advantages attained by their use in the making of mine maps. 1000 w. *Mines & Min*—July, 1898. No. 21408 C.

Legislation.

Mining Legislation in Indiana. Robert Fisher. A history of its development and the improvement of the condition in the mines up to the present time. Statistics for 1897. 1500 w. *Mines & Min*—July, 1898. No. 21407 C.

Mine Legislation and Inspection in the Anthracite Coal Region of Pennsylvania. G. M. Williams. Address before the International Mining Congress at Salt Lake City. States the salient parts of the law, and the benefits derived, reviewing the legislation enforced and the duties of inspectors. 2700 w. *Min & Sci Pr*—July 23, 1898. No. 21686.

The Last Chance Decision. Important decision of the U. S. Supreme Court. Full text. 3800 w. *Eng & Min Jour*—July 16, 1898. Serial. 1st part. No. 21511.

Reforms.

Needed Reforms in Mining. James Inglis. Read at meeting of Sydney Chamber of Commerce. Calling attention to the need of a new mining law for Australia, and discussing the special points needing correction. 2500 w. *Aust Min Stand*—May 19, 1898. No. 21334 B.

Rescue Apparatus.

Comparative Experiments with the Neupert and Walcher-Gärtner Rescue Apparatus. R. Heller, in *Oesterreichische Zeitschrift für Berg- und Huttenwesen*. Experiments made to ascertain the effect on respiration and circulation by the wearing of the apparatus and whether any and what kind of pathogenic symptoms supervened. 1300 w. *Col Guard*—July 1, 1898. No. 21456 A.

Tunnel.

The Cowenhoven Adit Level. David William Brunton. Contributed to the British Inst. of Civ. Engs. Describes the conditions existing in the silver mines of the Aspen district, Colorado, which necessitated the construction of this tunnel, the difficulties overcome, method of construction, ventilation, means of communication, expense, &c. Ill. 6400 w. *Col Guard*—June 24, 1898. No. 21331 A.

MISCELLANY.

Alloys.

Experimental Researches on the Metallic

Alloys. (Recherches Expérimentales sur les Alliages Métalliques.) G. Charpy. Devoted especially to the white antifriction alloys, with much valuable information and many tables; the whole forming a part of the work of the Commission on Alloys. 10000 w. Bulletin de la Société d'Encour—June, 1898. No. 21721 G.

Aluminum.

Aluminum as Fuel. Dr. H. Goldschmidt. From a paper read before the German Electrochemical Society, Leipsic. Explains the process of using aluminum as a refining and heat producing agent, and the adaptation of the working method to the purpose in view. 1600 w. Am Mfr & Ir Wld—July 1, 1898. No. 21367.

Bitumens.

The Technology of California Bitumens. S. F. Peckham. Facts relating to this vast accumulation, showing them to be of value, and reporting investigations and conclusions. 40000 w. Jour Fr Inst—July, 1898. No. 21301 D.

Brass.

See Mechanical Engineering, Shop & Foundry.

Cuba.

Mineral Resources of Cuba. Raimundo Cabrera. Translated from the Spanish by Louis Edward Levy. A general statement of the great riches, almost unexplored, of this island, including asphaltum, copper, iron, manganese and gold. Discussion. 7000 w. Jour Fr Inst—July, 1898. No. 21300 D.

Explosives.

Modern High Explosives. Louis Y. Schermerhorn. Portion of a topical discussion before

the Engs.' Club of Philadelphia. Defines the classes of explosives, their energy, effects, &c. 2500 w. Ir Age—July 28, 1898. No. 21667.

Ores.

The Concentration of Ores. A lecture by Prof. R. H. Richards, of the Massachusetts Institute of Technology, before the Society of Arts, Boston. Abstract. 1800. Mines & Min—July, 1898. No. 21412 C.

Persia.

The Mineral Resources of Persia. R. Helmacker. Reports showing large mineral resources, but little developed. 2200 w. Eng & Min Jour—July 9, 1898. No. 21434.

Phosphate.

The Phosphate Deposits of Tennessee. J. B. Killebrew. The first paper deals with the subdevonian phosphates, reviewing their discovery, extent, and mining. 4200 w. Mfrs Rec—July 8, 1898. Serial. 1st part. No. 21391.

Slate.

The Slate Regions of Pennsylvania. Mansfield Merriman. Gives the general characteristics of the states of the five Pennsylvania regions, with other information. Ill. 4000 w. Stone—July, 1898. No. 21622 C.

Smelting.

Lead Smelting in the Joplin, Missouri, District. E. Hedburg. Early history and the different processes now in use. A description of the Scotch lead furnace, also the Lewis Bartlett process and system of making sublimed white lead as carried on at the works of the Picher Lead Co. Ill. 2200 w. Mines & Min—July, 1898. No. 21409 C.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene and Its Modern Developments. Vivian B. Lewes. Read at Belfast meeting of the Incorporated Gas Inst. Considers the production, cost and utility of acetylene, discussing the generators, burners, dangers, &c., and its present standing. Discussion. 11400 w. Gas Wld—June 25, 1898. No. 21343 A.

Acetylene Gas Generators and the Essentials of Safety in their Construction and Use. J. Pemberton Stubbs. Read before the Incorporated Society of Inspectors of Weights and Measures. Part first is introductory dealing with the production of calcium carbide, and showing that with ordinary care little danger is risked in the use of acetylene. 2300 w. Engng—July 15, 1898. Serial. 1st part. No. 21638 A.

Apparatus for the Production of Acetylene Gas. From *Le Génie Civil*. Describes and illustrates two types, one having been in use for two years. 1200 w. Sci Am Sup—July 2, 1898. No. 21260.

Some Theoretical Aspects of Acetylene Manufacture. Calls attention to the great interest taken in this new illuminant, and the promising future awaiting it, considering briefly the chemi-

cal phenomena and reactions taking place during the decomposition of the carbide. 2700 w. Engr, Lond—June 24, 1898. No. 21327 A.

The Acetylene Gas Exhibition. General description of the exhibition now open at the Imperial Institute, London. 2200 w. Col Guard—July 1, 1898. No. 21460 A.

The Dangers of Acetylene. M. Ad. Bouvier. Read before the Société Technique du Gaz. Abstract, discussing the properties, risks and safeguards. 1400 w. Gas Wld—July 9, 1898. No. 21525 A.

Address.

President's Inaugural Address before the Incorporated Gas Institute, at Belfast, Ireland. James Stelfox. An interesting review of the progress of gas lighting, and of subjects important to the industry. 6800 w. Gas Wld—June 25, 1898. No. 21340 A.

Amendments.

The Necessity for Amendments in the Gas-Works Clauses Acts of 1847 and 1871. W. F. Cotton. Presented at Belfast meeting of the Incorporated Gas Inst. Calls attention to the particulars in which the defects of the acts work confusion and lead to litigation. 4400 w. Gas Wld—June 25, 1898. No. 21348 A.

Analysis.

Laboratory Notes on Gas Analysis. John T. Sheard. Describes a modification of Hempel's apparatus which is capable of giving quite exact results. 1200 w. Gas Eng's Mag—July 11, 1898. No. 21659 A.

Calcium Carbide.

The Calcium Carbide Industry. Editorial review of the remarkable activity displayed. 1300 w. Engng—July 15, 1898. No. 21637 A.

Cheap Gas.

The Cheapest Gas in the World. An interview with Mr. Isaac Carr, manager of the gas-works at Widnes, Eng., as to how this gas is produced. 2500 w. Gas Wld—July 16, 1898. No. 21647 A.

Fuel Gas.

The Cost of Fuel Gas. E. P. Reichhelm. On the value of this gas, showing that producer gas is often more expensive to use than illuminating gas. 800 w. Am Mach—June 30, 1898. No. 21247.

Incandescence.

Facts on the Theory of Incandescent Gas-light. Dr. G. P. Drossbach. From *Journal für Gasbeleuchtung und Wasserversorgung*. Gives experiments undertaken by the writer. 1200 w. Pro Age—July 1, 1898. No. 21274.

Two Incandescent Lights.—Gas v. Electric. J. H. Moxon. Suggestions for popularizing the incandescent gas burners. 1500 w. Gas Eng's Mag—July 11, 1898. No. 21658 A.

Meter Unions.

Standardizing of Meter Unions. Robert S. Carlow. Read at Belfast meeting of the Incorporated Gas Inst. A résumé of the reports and discussions of the North British Assn. Followed by discussion. 4000 w. Gas Wld—June 25, 1898. No. 21347 A.

Pintsch Gas.

The Manufacture of Pintsch Gas. Illustrates a typical plant installed at New Haven, Conn., for supplying the cars of the N. Y., N. H., and H. R. R. 1800 w. Sci Am—July 9, 1898. No. 21399.

Purifiers.

The Construction of and Mode of Working Purifiers. Henry Green. Read at Belfast meeting of the Incorporated Gas Inst. The paper is mainly devoted to a description of the purifiers of the Moor Lane station, Preston, and an account of their working. Discussion. Ill. 6600 w. Gas Wld—June 25, 1898. No. 21344 A.

Yeadon's Mechanical Purifying Machine. Illustrated description of the machine and its operation. 1600 w. Jour of Gas Lgt—July 19, 1898. No. 21671 A.

Retorts.

Inclined Retorts at Salford. S. Y. Shoubridge. Read at Belfast meeting of the Incorporated Gas Inst. An account of these retorts with reasons for the modifications introduced. Tables of comparative results, costs, etc., with other particulars. Discussion. Ill. 6000 w. Gas Wld—June 25, 1898. No. 21346 A.

The Brouwer-Rouget Coke-Conveyer and Retort-Charger. Illustrated description. 700 w. Jour Gas Lgt—June 21, 1868. No. 21483 A.

Valuation.

The Valuation of Gas Works for Assessment. William Newbigging. Read before the Belfast meeting of the Incorporated Gas Inst. Principally devoted to showing how faulty are the present methods. Discussion. 7000 w. Gas Wld—June 25, 1898. No. 21341 A.

Village Lighting.

Village Lighting: A Comparison. R. G. Shadbolt. Read at Belfast meeting of the Incorporated Gas Inst. Showing the effect on cost of electricity by using the oil engine, and its comparison with the price of gas; urging the same skill and economy in villages that is practiced in cities, thereby enabling the gas industry to successfully compete with electricity. Ill. 4000 w. Gas Wld—June 25, 1898. No. 21342 A.

Water Gas.

The Dellwik Method of Producing Water Gas. Carl Dellwik, in *Jernkontorets Annaler*. Illustrated description of this method, which claims to be sufficiently economical to meet the conditions of low cost. 1800 w. Ir & Coal Trds Rev—July 1, 1898. No. 21453 A.

Delwik's Water Gas. Abstract of a lecture recently delivered by the inventor before the Swedish Teknologförening at Stockholm. Ill. 1800 w. Ir Age—July 21, 1898. No. 21589.

SEWERAGE.**Cesspools.**

Odorless Cesspool Cleaning. Illustrated description of methods and apparatus used by Supt. of Health, at Malden, Mass. 700 w. Eng Rec—July 9, 1898. No. 21419.

Irrigation.

The Irrigation Fields of Berlin and their Discharge Water. (Die Rieselfelder der Stadt Berlin und ihre Abwasser.) A discussion with professional opinions upon the nature of the drainage from the sewage irrigated farms near Berlin, with chemical analyses. 4000 w. Gesundheits-Ingenieur—June 15, 1898. No. 21765 D.

Nottingham, Eng.

The Sewerage of Nottingham, Eng. James H. Fuertes. Describes and illustrates a 900-acre sewage farm. 1200 w. Eng Rec—July 16, 1898. Serial. 1st part. No. 21505.

Pipe Joints.

Sewer Pipe Joints in England. John A. Turner. Illustrated description of various types. 2000 w. Brick—July, 1898. No. 21319.

Purification.

On the Use of Coke Breeze in Sewage Purification. John W. Alvord. Detailed review of the development of coarse grain filters, and experiments relating to them. Discussion and correspondence. 6000 w. Jour W Soc of Eng's—June, 1898. No. 21438 D.

Sewage Disposal.

Soil Pollution from Careless Disposal of Sew-

age. F. A. Lyman, in the *Medical Age*. Showing the danger arising from this source and the great importance of securing pure air and pure water. 1300 w. San Rec—July 8, 1898. No. 21519 A.

Sewer Construction.

The Mechanical Plant of the Great Clichy Collecting Sewer. (Les Installations Mécanique du Grand Collecteur de Clichy.) R. Legouëz. Describing the various mechanical devices used in the construction of this great Paris sewer; including shields, hydraulic cylinders, conveyors, pumps, motors, &c., &c. 7500 w. Revue de Mécanique—May, 1898. No. 21727 H.

Sewers.

Carrying a Steel Pipe Sewer Across a Bridge at London, Ontario. Describes the carrying of a 36-in. main across the river Thames, at an elevation of 24-ft. above low water, at London, Ontario, Ill. 600 w. Eng News—July 14, 1898. No. 21487.

The Effective Prevention and Dissemination of Noxious Gases in Sewers. Frank Latham. On the proper means of sewer ventilation, so as to remove the gaseous effluvia in a manner that will least tend to vitiate the air. 1500 w. San Rec—July 15, 1898. Serial. 1st part. No. 21621 A.

The Sewerage System of Depew, N. Y. Illustrated description of details of sewers and chemical treatment works for sewage disposal. 1200 w. Eng Rec—July 9, 1898. No. 21418.

STREETS AND PAVEMENTS.

Guaranties.

Asphalt Paving Guaranties. Review of decision of New Jersey Court of Appeals upholding contracts for asphalt paving with a 5-year guaranty clause. 600 w. Eng Rec—July 23, 1898. No. 21611.

London.

London Improvements. Discusses the schemes for the widening of the Strand and other street improvements. 1600 w. Ill Car & Build—July 1, 1898. No. 21430 A.

Paving Materials.

Street Paving Materials. J. J. Bell. General review of the materials that have been used in various localities, with statement of the cost per sq. yd. of the pavements in use in Toronto, Can. 1200 w. Can Engr—July, 1898. No. 21567.

Roads.

Tar in Road Making. Extracts from paper of A. H. Campbell read at Edinburgh meeting of the Assn. of Municipal & County Engrs., in the use of tarred macadam in the construction of roadways. 1800 w. Gas Wld—July 9, 1898. No. 21526 A.

Street Improvements.

Rebuilding of Central Florence. From report of British Consul-General Chapman. Brief account of the project to clear out the more central part of the town and trace larger and more regular streets, and otherwise improve the

locality. 1200 w. Arch, Lond—July 8, 1898. No. 21527 A.

WATER SUPPLY.

Bangor, Maine.

The Hydraulic Plant for the Bangor Water Works. Illustrated description of a 10,000,000-gal. pumping station driven by water power, in which unique arrangement of turbines was necessary to allow for tidal fluctuations. 2500 w. Eng Rec—July 2, 1898. No. 21308.

Early Methods.

Early Methods of Collecting, Storing, and Distributing Water. William R. Hill. Read at meeting of Am. Water Works Assn. Reviews the ancient works of various countries, showing advances made. 4000 w. Munic Engng—July, 1898. No. 21479 C.

Examination.

The Chemical and Bacteriological Examination of Water. Percy F. Frankland. Abstract of paper read at meeting of British Assn. of Water-Works Engrs. Discusses the purification of water, and the importance of bacteriological examination. Discussion. 3500 w. Jour Gas Lgt—June 28, 1898. No. 21485 A.

Explosion.

The Cleveland Tunnel Explosion. An account of a gas explosion in a water-works tunnel, killing 11 men. 1000 w. Eng Rec—July 23, 1898. No. 21612.

Filtration.

Filtration at Elgin, Illinois. Illustrates and describes a very complete system. 600 w. Fire & Water—July 23, 1898. No. 21643.

Mechanical Filtration. W. P. Mason. Read at meeting of the Am. Water Works Assn. Notes on the experiments made at the Elmira filtering plant by order of the U. S. Courts. 1200 w. Munic Engng—July, 1898. No. 21482 C.

Water Filtration at Cardiff, Wales. Describes three open sand filters. 1200 w. Eng Rec—July 2, 1898. No. 21309.

Havana.

The Sanitary Regeneration of Havana. George M. Sternberg. Describes the sanitary condition of this city, and discusses the possibility of regeneration, considering that if placed in a satisfactory sanitary condition as regards its dwellings, sewers, and pavements, it would be practically immune from yellow fever. 4400 w. Century Mag—Aug., 1898. No. 21684 D.

Jersey City, N. J.

Water for Jersey City, N. J. Editorial showing the foolishness of the specifications adopted for works. 1100 w. Eng Rec—July 9, 1898. No. 21414.

New Works.

New Works for the Water Supply at Gosport. E. T. Hildred. Read at meeting of the British Assn. of Water Works Engrs. Abstract. Description and discussion. 3500 w. Jour of Gas Lgt—June 21, 1898. No. 21484 A.

New York's Supply.

Greater New York's Water Supply. F. B.

Thurber. Calling attention to the need of additional supply in Brooklyn, and suggesting the Catskills as a source of supply, quoting from discussions of the subject. 3800 w. N Am Rev—July, 1898. No. 21291 D.

Rates.

An Unusual Suit Over Water Rates. Editorial review of a decision of the Massachusetts Supreme Court concerning the use of meters. 800 w. Eng Rec—July 16, 1898. No. 21500.

Liability for Unpaid Water Rates. Review of decision of Massachusetts Supreme Court defining liability of tenant for unpaid rates of previous tenants. 1300 w. Eng Rec—July 2, 1898. No. 21307.

Water Meters and Rates. John B. Heim. Read at meeting of the Am. Water Works Assn. Discusses the advantages of using meters, the rates, &c., giving illustrations from experience. 3300 w. Munic Engng—July, 1898. No. 21480 C.

Reservoirs.

Cleaning Reservoirs. Dow R. Gwinn. Read at meeting of the Am. Water Works Assn. Gives the writer's experience in this work. 1000 w. Munic Engng—July, 1898. No. 21481 C.

The Twin Lakes Reservoir, Colorado. W. P. Hardesty. Describes the great natural advantages, and the work necessary in adapting the site for the conservation of water supplies.

1100 w. Eng News—June 30, 1898. No. 21251.

Water Supply.

A Comparison between the Water Supply of Vienna and of Paris. (Einige Vergleichende Mittheilungen über die Wasserversorgungs-Verhältnisse in Wien und in Paris.) Carl Sykora. With interesting data concerning sources, reservoirs and distribution in the two cities. 4000 w. Zeitschr Oesterr Ing u Arch Ver—July 1, 1898. No. 21731 B.

Water Works.

Sources, Modes of Supply and Filtration of Public Water Supplies in the United States. Figures taken from a graduating thesis of Benjamin H. Flynn, compiled by him from the "Manual of American Water Works" for 1897. 1400 w. Eng News—July 7, 1898. No. 21386.

The St. Louis Water-Works. Editorial on proposal to prevent alienation of works except by popular vote. 700 w. Eng Rec—July 9, 1898. No. 21413.

MISCELLANY.

Fire Regulations.

Fire Resisting Construction. G. A. T. Middleton. A discussion of the regulations in force in London, both as regards general buildings and places of entertainment. 2500 w. Engineering Magazine—August, 1898. No. 21796 B.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in June, 1898. Detailed list and classified summary, with comments. 3000 w. R R Gaz—July 22, 1898. No. 21599.

Blockade.

A Blockade on the New York, New Haven and Hartford. An account of the damage to the double-track bridge over the Housatonic River, five miles east of Bridgeport, and the management of trains during the blockade, which lasted 41 hours. 1400 w. R R Gaz—July 8, 1898. No. 21396.

Car Service.

Per Diem Car Service. Editorial discussion of Mr. Daly's scheme for the use of exchanged cars. 1200 w. R R Gaz—July 8, 1898. No. 21398.

Circus Train.

An American Circus Train in England. Instructions contained in a circular, issued by the Midland Railway of England, for the handling of the Barnum & Bailey circus train from Sheffield to Leeds. 1200 w. Ry Age—July 22, 1898. No. 21644.

Conventions.

The Work of the Railway Mechanical Conventions of 1898. Editorial discussion of the action to bring about a consolidation of the organizations, and the forces which are tending to

unite the associations, with other features of the conventions. 2800 w. Eng News—June 30, 1898. No. 21252.

Grain Elevators.

Elevator System of the Illinois Central R. R. at New Orleans. Illustrates and describes the grain handling facilities, and the recent improvements. 1500 w. Ry & Engng Rev—July 23, 1898. No. 21646.

Mileage.

Car Mileage Records. A. O. Kittredge. Gives a brief survey of the practice of several companies. 2000 w. St Ry Jour—July, 1898. No. 21377 D.

Train Services.

The July Train Services. Charles Rous-Marten. Reviews the most prominent features of the July alterations in England from an engineering view-point, in relation to the progress or retrogression shown by the various railways. 2000 w. Engr, Lond—July 8, 1898. No. 21556 A.

The London and Liverpool Train Service. Editorial criticism of the service on the London and North Western Railway, with discussion of the situation. 1200 w. Engng—July 8, 1898. No. 21543 A.

Train Service in England. W. M. Acworth. States the condition of train service in England as compared with the United States and France, and the efforts being made to improve the English service. 1000 w. R R Gaz—July 8, 1898. No. 21392.

Union Pacific R. R.

Across Wyoming by the Union Pacific. W. P. H. Letter calling attention to the features of interest to an engineer. 4000 w. Eng News—June 30, 1898. No. 21253.

FINANCIAL.

Earnings.

Railroad Earnings Still Favorable. Report for June, 1898, with comparative tables. 2800 w. Bradstreet's—July 16, 1898. No. 21496.

LEGAL.

Interstate Commerce.

The Railroads and the Interstate Commerce Law. Address of M. E. Ingalls at the convention of the Railroad Commissioners at Washington. Discusses the difficulties and the changes in legislation needed. 3800 w. Ir Age—July 7, 1898. No. 21382.

Swiss Railroads.

The Nationalization of Swiss Railroads. W. M. Acworth. Extracts from a paper written for the *Economic Journal*. Gives an outline of the organization for the government of railroads, and discusses the prospects. 1300 w. R R Gaz—July 8, 1898. No. 21394.

MOTIVE POWER AND EQUIPMENT.

Air-Brake Hose.

Specifications for Air-Brake Hose. Report of committee to Master Car Builders' Assn. Discusses the manufacture of hose, the causes of weakness, giving recommended specifications and tests. Ill. 3000 w. Am Eng & R R Jour—July, 1898. No. 21352 C.

The Unwinding Test for Air-Brake Hose. G. P. Campbell. Report of test made, with some facts concerning rubber. Also a letter from a maker. 1500 w. R R Gaz—July 22, 1898. No. 21598.

American Railways.

Railways in America. (Les Chemins de Fer en Amerique.) P. Pasquier. A comparison, mainly as regards speed, between American and European railways. 6000 w. Revue Universelle des Mines—June, 1898. No. 21719 H.

Bearings.

Center Bearings or Side Bearings. Extracts from an interesting discussion at the May meeting of the Western Railway Club. 2000 w. R R Gaz—July 15, 1898. No. 21492.

Car Axles.

An Axle for Heavy Cars. Extracts from letter of E. D. Nelson, presented at the M. C. B. convention, on this subject. 900 w. R R Gaz—July 1, 1898. No. 21267.

Car Lighting.

Acetylene and Mixed Gas Plants for Lighting Railway Cars. (Acetylen-und Mischgasanstalten für Beleuchtung der Eisenbahnwagen.) A paper by Herr Bork describing a plant for the production of calcium carbide, and acetylene in connection with oil gas, the whole forming a complete car-lighting plant. 4500 w. 1 plate. Glaser's Annalen—June 15, 1898. No. 21740 D.

Electric Power.

The Application of Electricity to Steam Railroads. D. W. Brangs. Read before the Am. Ry. Master Mechs. Assn. Reviews the various methods by which electricity can be applied for heavy railroad work, and its advantages. 1800 w. Elec Rev, N. Y.—July 20, 1898. No. 21571.

Guard Communication.

Electrical Passenger and Guard Communication. Illustrated description of arrangements employed on the Great Eastern Railway of England. 700 w. Transport—July 8, 1898. No. 21533 A.

Railway Passenger Communication. Report of the committee appointed by the British Board of Trade, to consider points relating to the means of communication between passengers and guards on railway trains. 3200 w. Elec Engr, Lond—July 15, 1898. No. 21652 A.

Locomotives.

A Suggestion for the Improvement of the Locomotive. George S. Strong. Gives the writer's ideas in regard to American practice and its limitations, with a suggestion regarding the use of feed-water heaters for locomotives. 1000 w. R R Gaz—July 22, 1898. No. 21597.

Consolidation Locomotive for Southern Railway. Illustrated description with dimensions. 700 w. Ry & Engng Rev—July 16, 1898. No. 21566.

Eight-Wheel Passenger Locomotives—Cleveland, Cincinnati, Chicago & St. Louis Railway. Illustrated description with principal dimensions. 1000 w. R R Gaz—July 15, 1898. No. 21491.

Geared Locomotives on the Mount Tamalpais Railway. Illustrated description of a 30-ton engine of the central shaft class, designed by Charles Heisler, and running on a scenic railway in California. 1300 w. Sci Am—July 16, 1898. No. 21473.

London and Southwestern Express Locomotive of 1856. Herbert T. Walker. Illustrates and describes an old engine designed by Joseph Beattie. 900 w. R R Gaz—July 29, 1898. No. 21687.

New High-Speed Compound Locomotives. (Les Nouvelles Locomotives Compound à Grand Vitesse.) An illustrated account of the fine new four-cylinder compound engines, constructed for the Northern Railway of France. 2500 w. Génie Civil—July 9, 1898. 1 plate. No. 21716 D.

Old Locomotives, Dublin and Kingstown Railway. Illustrated description of the Jupiter, one of the standard engines of this line, constructed in 1840. 450 w. Engr, Lond—June 24, 1898. No. 21329 A.

Ten-Wheel Passenger Locomotives; Grand Trunk Ry. Illustration, description, and principal dimensions. 500 w. Eng News—July 28, 1898. No. 21693.

The New North British Express Engine. Charles Rous-Marten. Information relating to the new "729" class of locomotives with report of tests of actual working made by the writer. 1600 w. Engr, Lond—July 1, 1898. No. 21468 A.

Wiredrawing.

The Wiredrawing of Steam in Locomotives. (*Die Drosselung des Dampfes bei Lokomotiven.*) A discussion, by Inspector Leitzmann, of the throttling action of the locomotive valve gear at early cut-off, illustrated by diagrams. 3500 w. Glaser's Annalen—June 15, 1898. No. 21741 D.

NEW PROJECTS.**Cuba.**

The Railroads of Cuba. A sketch map with information from various sources. 900 w. R R Gaz—July 8, 1898. No. 21395.

Newfoundland.

Newfoundland's Railway Completed. An account of the accomplishment of an undertaking which unites all of England's possessions in this quarter of the globe. 900 w. Sci Am Sup—July 23, 1898. No. 21588.

PERMANENT WAY AND FIXTURES.**Complicated Tracks.**

Track Elevation and Depression at the 16th St. Crossing, Chicago. This section, which is probably the most complicated system of grade crossings in Chicago, is illustrated and described. 1800 w. Eng News—July 14, 1898. No. 21488.

Cross Ties.

Comparative Tests of Metallic Cross Ties. (*Essais Comparatifs de Traverses Métalliques.*) A very full report of the results of tests of various kinds of metallic ties on the Netherlands State Railways from 1881 to 1898, with plate showing the forms tested. 6000 w. 1 plate. La Revue Technique—July 10, 1898. No. 21709 D.

Freight Yard.

A Novel City Freight Yard. Illustrates the freight yard of the Harlem Transfer Co., 135th St., New York City. It was designed by Walter G. Berg, and presents many interesting features. 1000 w. R R Gaz—July 29, 1898. No. 21689.

Interlocking.

Pneumatic Interlocking at Exchange Street,

Buffalo. Describes a plant for the N. Y. C. & H. R. R., containing 25 switches and 33 signals, in which all the functions are performed by compressed air. Ill. 1500 w. R R Gaz—July 8, 1898. No. 21393.

Railway Curves.

On the Relation Between the Radii of Railway Curves and the Wheel-Bases of Vehicles and locomotives. A. Hallbauer. Translated from the *Organ für die Fortschritte des Eisenbahnwesens*. Mathematical. 900 w. Ind Engng—May 28, 1898. No. 21380 D.

Sanding.

Track Sanding Arrangement. Illustrates a new and exceedingly simple design which is not patented. 700 w. R R Gaz—July 15, 1898. No. 21493.

Signals.

Electric Block Signals on the Boston and Albany. George W. Blodgett. Illustrated description of signal apparatus used, with discussion of systems and their operation, and showing that for some purposes and conditions, wire circuits can be used to better advantage than rail circuits. 3300 w. R R Gaz—July 22, 1898. No. 21600.

Improvements in Track Circuit Controlling Devices for Electrically Controlled Block Signals. R. J. Hewett. Considers improvements which provide a track circuit arrangement for actuating track relays at both ends of the track circuit. 1600 w. Ry & Engng Rev—July 16, 1898. No. 21565.

Uniformity and Consistency in the Use of Fixed Signals. Editorial on the recent address of F. A. Delano at Purdue University upon the use of railway signals. 1300 w. R R Gaz—July 29, 1898. No. 21692.

Station.

The New Paris Station of the Paris, Lyons, and Mediterranean Railway. Plans and sections of the work, with description. 2200 w. Engng—July 1, 1898. No. 21461 A.

The New Railroad Station at Dresden. From the *Illustrirte Zeitung*. Brief illustrated description. 800 w. Sci Am Sup—July 2, 1898. No. 21262.

STREET AND ELECTRIC TRAMWAYS.**Accounting.**

Some Graphical Diagrams Used in the Operating and Accounting Departments. Treats of the application of graphical charts to railway records. 4000 w. St Ry Rev—July 15, 1898. No. 21516 C.

Alternating Currents.

The Application of Alternating Currents to Electric Traction. Chas. Henry Davis and Howard C. Forbes. A discussion of the economic advantages to be gained by the use of alternating currents, and the methods of transforming and controlling them. Part I. 3500 w. Engineering Magazine, August, 1898. No. 21799. B.

Batteries.

Storage Batteries. Interesting information relating to storage batteries and their efficiency. Ill. 2000 w. St Ry Rev—July 15, 1898. No. 21517 C.

Storage Battery Railroading. E. R. Gilbert. Considers the advantages and disadvantages of this system in comparison with other means of propulsion. 1800 w. St Ry Rev—July 15, 1898. No. 21518 C.

Brooklyn Bridge.

Surface and Elevated Cars on the New York and Brooklyn Bridge. Presents the situation, giving facts regarding the decrease in revenue, as the results of running the electric surface

cars, and the elevated railroad cars. 2000 w. R R Gaz—July 1, 1898. No. 21268.

Circuits.

The Overhead Line and Ground Return Circuit of Electric Street Railways. David Pepper, Jr. Reviews the important points in construction, and the progress made. 3600 w. Jour Fr Inst—July, 1898. No. 21302 D.

Controller.

The Henry "Regenerative" Controller for Electric Cars. John C. Henry. Presents the advantages claimed for this new system. 2000 w. Elec Eng, N. Y.—July 21, 1898. No. 21575.

Corea.

An Electric Railway in Corea. H. Collbran. A letter giving information concerning a street railway being constructed in Seoul, the capital city of Corea. Ill. 600 w. Ry Age—July 22, 1898. No. 21645.

Duisburg.

An illustrated description of the electric trolley road between Duisburg and Düsseldorf, with profile of the route and photographs of the trolley drawbridges. 2000 w. Ill. Zeitschr für Klein und Strassenbahnen—July 1, 1898. No. 21775 D.

Electric Traction.

Electric Railway System of the Meadville Traction Company. Brief illustrated description of a road in Pennsylvania, constructed according to the latest methods. 900 w. St Ry Jour—July, 1898. No. 21375 D.

The Hull Electric Railway. F. C. Armstrong. Illustrates and describes a branch road in Canada, recently equipped electrically. It has a considerable freight business in hauling lumber, grain, &c. 1800 w. St Ry Jour—July, 1898. No. 21374 D.

The System of the Schuylkill Valley Traction Company, Norristown, Pa. Map and illustrations of this line which passes through historic and very picturesque territory. 1500 w. St Ry Jour—July, 1898. No. 21376 D.

Elevated Road.

The Electric City Railway in Berlin. (Die Elektrische Stadtbahn in Berlin.) M. Foerster. A general description of the electric elevated railway in Berlin, with many illustrations of the structure and stations. 3000 w. Mitt des Ver f d Förd des Local- u Strassenbahnwesens—June, 1898. No. 21773 E.

Feeders.

Underground Feeders for Electric Traction. Charles E. Morris. Refers briefly to various methods adopted and their advantages and disadvantages. Ill. 1000 w. Ry Wld—July 7, 1898. No. 21618 A.

Franchises.

Relation of Cities and Towns to Street Railway Companies. L. S. Rowe. Comments on the recent report of the special committee appointed by the Governor of Massachusetts to investigate the relations between cities and towns and street-railway companies. 2200 w. An of Am Acad—July, 1898. No. 21558 G.

Goods Traffic.

The Unconscious Ownership of an Important Key. W. T. Bonner. Read at meeting of the Can. Elec. Assn. A plea for the introduction of goods traffic on our suburban railways, with discussion. Ill. 6600 w. Can Elec News—July, 1898. No. 21563.

Halifax.

Halifax Corporation Electric Tramways. Illustrated detailed description. 3000 w. Ry Wld—July 7, 1898. No. 21617 A.

Magnetic Disturbances.

The Disturbance of Magnetic Observatories by Electric Railways. (Ueber die Störungen Magnetischer Observatorien durch Electricische Bahnen) W. v. Bezold. Refers especially to the experience of the magnetic observatory at Potsdam, and shows that the permissible distance for electric railways is too close, also that position as well as distance should be considered. 2000 w. Elektrotech Zeitschr—June 16, 1898. No. 21754 B.

Manhattan Transit.

The Immediate Betterment of Manhattan Transit. O. F. Nichols. Proposes a system for the betterment of the facilities of the Manhattan Elevated Railway. Ill. 4000 w. R R Gaz—July 1, 1898. No. 21266.

Mountain Railway.

A Proposed Mountain Railroad for the Tyrol. From the *Illustrirte Zeitung*. An account of the plans being considered for an electric railroad from Gossensass to Amthorspitz, which commands an extensive and very beautiful view. 300 w. Sci Am Sup—July 16, 1898. No. 21477.

The Zermatt-Gornergrat Mountain Railway. Brief description of an interesting and instructive railway undertaking in Southern Switzerland. Ill. 1300 w. St Ry Rev—July 15, 1898. No. 21515 C.

The Zermatt-Gornergrat Electric Rack Railway. Abstract from article in *Le Génie Civil* describing this road. 1200 w. Eng News—June 30, 1898. No. 21255.

N. Y. City Railroads.

The Motive Power of the City Railroads of New York. H. G. Prout. From the *N. Y. Times*. Discusses the peculiar difficulties to be met in this city, and the steps being taken. 1800 w. Ir Age—July 28, 1898. No. 21668.

Open Cars.

Guards for Open Cars. Illustrated description of various devices in use. 1800 w. St Ry Rev—July 15, 1898. No. 21514 C.

Passenger Capacity.

A Plan to Increase the Passenger Capacity of the Wannsee Railway. (Ein Vorschlag zur Verbesserung der Verkehrsverhältnisse auf der Wannseebahn.) A discussion of the various methods proposed to provide for the rapid increase in travel on an electric road. 2500 w. Deutsche Zeitschr f Elektrotech—June 15, 1898. No. 21766 H.

Pittsburg, Pa.

Notes from the Field—Electricity on the

Pittsburg Street Railways. C. B. Fairchild. Part first is a description of the plant and equipment of the Consolidated Traction Company. 3000 w. Elec Eng, N. Y.—July 21, 1898. No. 21574.

Power.

Power Transmission and Distribution for Railway Work. Ernst J. Berg. Explains the method of control of potential in the converter station, discussing its effects on the operation in general. 4300 w. Trans of Am Inst of Elec Engs—May, 1898. No. 21283 D.

Rapid Transit.

Some Phases of the Rapid Transit Problem. Albert H. Armstrong. Discusses various methods of train acceleration to determine the methods of running with the least expenditure of energy. 4200 w. Trans of Am Inst of Elec Engs—May, 1898. No. 21281 D.

Storage Battery.

An Electric Railway Storage Battery Plant. An illustrated description of the storage battery plant of the Buffalo Railway Company. 1000

w. Am Elect'n—July, 1898. No. 21368.

Stettin.

The Electric Street Railway at Stettin. (Elektrische Strassenbahn Stettin.) A fully illustrated description of the new electric tramway system recently installed in the capital of Pomerania. 4000 w. Ill. Zeitschr für Klein-und Strassenbahnen—June 16, 1898. No. 21774 D.

Underground.

The New Underground Railway in London. (Le Nouveau Chemin de Fer Souterrain de Londres.) An account, from a French point of view, of the Central London Railway, with plan of the route and a plate showing arrangement of the power plant and construction of the electric locomotives. 3500 w. 1 plate. Le Génie Civil—June 25, 1898. No. 21712 D.

The Waterloo and City Railway. An account of the formal inauguration of the line though not yet open for public traffic. 1800 w. Transport—July 15, 1898. No. 21661 A.

Waterloo and City Railway. Brief account of this deep-tunnel railway recently inaugurated. 2300 w. Engng—July 8, 1898. No. 21544 A.

We supply copies of these articles. See introductory.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

Clarke Chapman & Co., Ltd., Gateshead-on-Tyne, England.=Illustrated catalogues (a) of pumping machinery for boiler feeding, hydraulic and mining work, fully coded with tables of capacities, floor space, etc.; (b) of windlasses and hoisting machinery for ships, fully coded with statements of admiralty requirements, Lloyds and Bureau Veritas rules, and tables of anchors and chains.

Charles Clifford & Son, Ltd., Birmingham, England.= (a) Price list of copper, brass, and yellow metal in rods, wire tubes or sheet form, with tables of weights and gauges; (b) Large sheet of designs for ornamental tubing.

Alfred Herbert, Ltd., Coventry, England.= Illustrated catalogue and price list of machine tools, milling machines, cutter grinders, sensitive drills, capstan lathes, and special machinery for cycle manufacture. Well printed and fully illustrated.

John Wallis Titt, Woodcock Works, Warminster, Wilts, England.=Catalogue of wind engines and pumps. Prices and dimensions are invariably given and some useful notes on wind power and how to utilize it are appended.

Cash Robinson & Co., Woodville Electrical Works, Burton-on-Trent, England.=Price list of "Bristol" dynamos.

Sam. H. Rawley, Swadlingcote, Burton-on-Trent, England.= (a) Illustrated price list of sinks, basins and other sanitary appliances; (b) Several page price lists of railway lavatories and similar fittings.

The Ebbw Vale Steel, Iron & Coal Co., Ltd., Ebbw Vale, Mon., England.=Catalogue of steel springs for railway trucks, locomotives, and wagon buffing. Each design illustrated.

Tinker & Co., Globe Boiler Works, Dunkinfield, England.=Circular with illustrations of steel, Lancashire, Cornish and multitubular boilers.

Wm. Singleton, Newland Works, Lincoln, England.=Price list of waterproof wagon covers, jute stack sheets and horse clothing.

W. H. Bailey & Co., Salford, Manchester, England.=Circular describing the "Full-Bore" reducing valve for steam-air or water.

Thomas Perry & Son., Ltd., Highfield Works, Bilston, England.=Illustrated price list of safes, strong room doors, etc.

The Longford Wire, Iron and Steel Co., Warrington, England.=Illustrated catalogue of galvanized wire spring mattresses and bedsteads, seats and backs for railway carriages and wire cycle saddles, with prices, list of users and testimonials.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Record of recent construction, No. 6.

Pamphlet containing handsome illustrations of locomotives of all sorts recently built for railways in North and South America, as well as Europe, Asia, and Africa.

Baldwin Locomotive Works, Philadelphia, Pa., and Westinghouse Electric and Manufacturing Co., Pittsburg, Pa., U. S. A.=Beautifully printed and illustrated pamphlet showing the electric mining locomotives for underground haulage.

Buffalo Forge Company, Buffalo, New York, U. S. A.=Folder giving illustrations and description of the Buffalo Automatic Engines, both vertical and horizontal, single and double.

Westinghouse Electric and Manufacturing Co., Pittsburg, Pa., U. S. A.=Electricity for Machine Driving; a handsome pamphlet with numerous illustrations showing the advantages to be secured by the use of the electric current, instead of long lines of belting and shafting, for the transmission of power; many applications of the Tesla poly-phase motors are shown.

John A. Roebling's Sons Company, Trenton, New Jersey, U. S. A.=Catalogue and price list of wire rope, and wire-rope fastenings, iron, copper, brass and steel wire, hard copper telephone wire, bi-metallic wire, copper wire and cables for electrical purposes; with descriptive notes on cableways and tramways, suspension bridges, transmission of power by wire rope, inclined planes, and wire rope haulages.

The Ingersoll-Sergeant Drill Co., New York.=Catalogue No. 32. Devoted to compressors for all kinds of service, with many illustrations of straight-line, half-duplex, duplex, and compound air-compressors, arranged to be driven by various sources of power. Many valuable tables of useful information are given.

The Consolidated Safety Valve Company, New York.=Catalogue of Richardson and Ashcroft "Pop" safety valves for use on stationary, marine, locomotive, and portable boilers. Illustrations of the various types are given, and numerous testimonials from extensive users.

The Cincinnati Corrugating Co., Piqua, Ohio, U. S. A.=Catalogues (a) of corrugated steel arches for use in fire-proof building construction; (b) describing corrugated sheet metal roofing, with the improved edge corrugation, insuring tight joints.

Sprague Electric Company, New York.=Handsomely illustrated catalogues (a) of junction boxes for electric conduits; (b) of Lundell slow speed electric motors; (c) of Lundell fan motors.

R. Hoe & Co., New York.=Pamphlet showing the improved printing presses used in the United States Government printing office, together with a long list of users of large Hoe presses all over the world.



BINDING SECT. AUG 14 1980

TA
1
F25
v.15

Engin.

Factory and industrial
management

ENGINE STORAGE

**PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET**

UNIVERSITY OF TORONTO LIBRARY
